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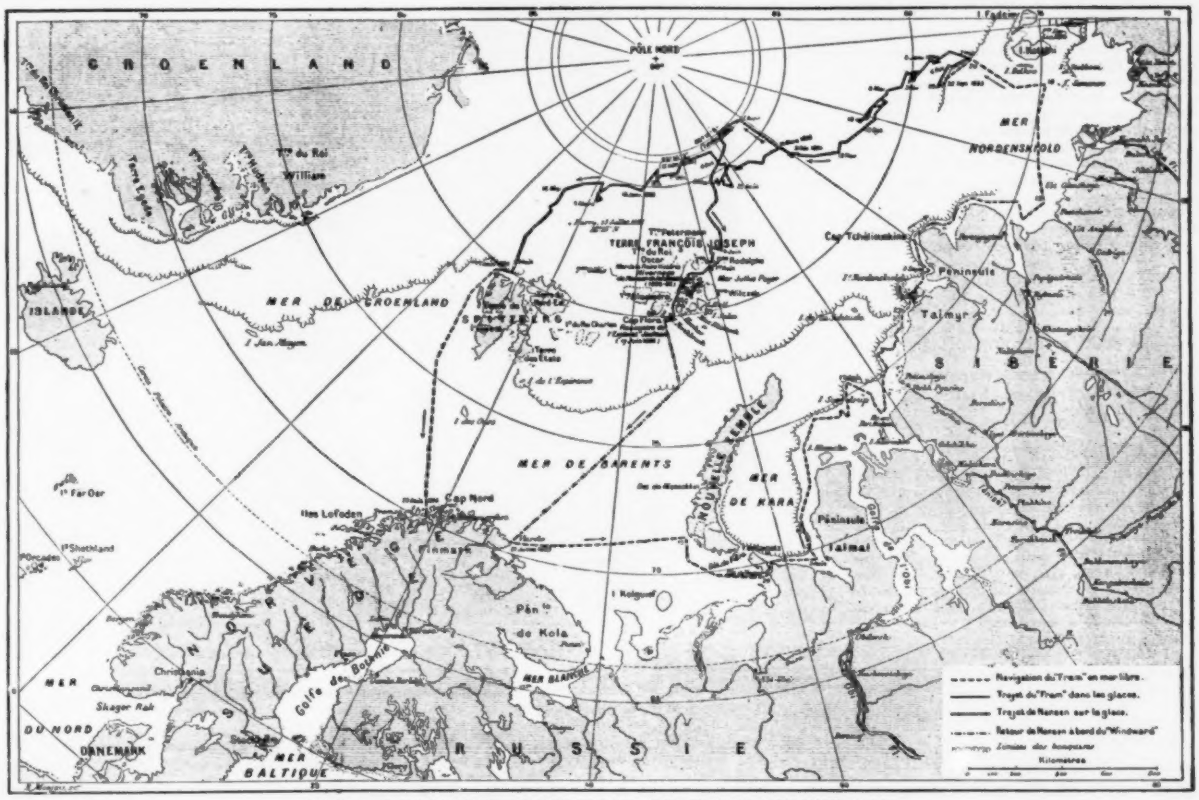


MAP OF NANSEN'S EXPEDITION (JULY, 1893-AUGUST, 1896).

A SUMMER SCENE IN THE POLAR REGIONS (JULY, 1894).

NANSEN'S NORTH POLAR EXPEDITION.

ONE day, while the Fram was imprisoned in the ice of the Kara Sea, Nansen wrote in his journal this sententious sentence: "Patience is one of the medicines with which every polar expedition ought to be most liberally provided." On board of the Fram, scarcely anything but this was used for three years, and especially at the beginning.

The Strait of Yougar, one of the southern entrances to this sea, was traversed on August 4, 1893, but it was not until September 10 that Cape Tchelionskine was doubled. On August 9 the Fram was finally able to put the cape to the north. Despite contrary winds and floating ice, she sailed toward the east, after doubling Cape Skaratof and White Island. On the way, Nansen and Sverdrup observed a certain number of islands not set down by Nordenskjold, while other lands that appear upon the map of the illustrious navigator of the Siberian seas escaped them—a detail that proves how incomplete and imperfect the geography of these regions still is.

The Fram was to have put into port at Dickson Island in order to allow the members of the expedition to leave some letters there under a cairn, Capt. Wiggins having promised to collect the mail in visiting the mouth of the Yenisei. But the wind, which had for some days been causing the ship to drift toward the southwest, had fallen. Too much time had been lost already, and in order to take advantage of the lull, Nansen and his companion sacrificed this occasion to give news of themselves to those who were most dear to them.

At Kjellman Island, which resembles rocks that might have been polished by quaternary glaciers, it was necessary to put in in order to make repairs to the boiler.

It was now the 22d of August. In the narrow channel open along the shores, the current was as swift as a river, and the Fram had it against her. It was slowly and with trouble that Nansen's ship made her way toward the northwest amid a true archipelago of unknown islands.

On September 10, as before stated, Cape Tchelionskine was reached. At four o'clock in the morning the flag was raised and a salute of three guns was fired.

It now seemed, as Nansen had announced, as if the greatest of the difficulties had been overcome. Although Nordenskjold Sea was not free enough from ice to allow the Fram to take a short cut, the navigation was easy in following the shore. After harpooning a few walruses upon the east coast of the peninsula of Taimyr, Nansen sailed his ship rapidly toward a place where he might expect to find, and where in fact he did find, the sea nearly free, viz., to the north of the delta of the Lena, whose enormous discharge of relatively warm water repulsed the ice pack in creating a current and in raising the temperature of the sea within quite a wide radius.

On September 18, to the west of Belkov Island, the Fram found the sea free and the route open to the north. It was an enchantment. Of winter, it was no longer a question. The sun shone in the afternoon, and, at night, Nansen and his companions, sailing as speedily as wind and steam could carry them along toward unknown regions and upon an immense rough sea that had never before been plowed by any ship, might have thought themselves several hundred miles more to the south, so balmy was the air and so distant seemed to be the ice floe.

On September 20, however, the Fram, on a foggy morning, suddenly found herself face to face with the floe. The ice of this was compact, and after the sun appeared Nansen found that it extended to the east and west further than the eye could reach. The Fram met with the floe in latitude 77° 44'. The next day and the day after he followed the edge of it, which turned up toward the northwest. On September 22, having made about a degree, he reached the extreme southern limit of the open sea. A sounding of 395 meters did not find bottom. On this day the expedition entered its second phase. According to all appearances, the Fram, behind which the open sea that she had just traversed had suddenly frozen, was to be imprisoned for a long time. Nansen reckoned that he would not get out of the ice before having been carried along by it from the other side of the pole toward the Atlantic Ocean. The sun was daily declining in the heavens and the temperature was constantly falling. This time it was really winter that was approaching and with rapid strides—the Arctic winter, the long polar night, the dreaded night. The expedition had nothing to do but to prepare for it. The transformation of the ship began. The rudder was unshipped, but the screw was left in place, since its cage contributed toward strengthening the stern of the vessel. The engine was taken apart piece by piece, and, in order to better distribute the load, the coal was hoisted from the hold and the bunkers were filled with it. A carpenter's shop was installed in the hold; a machine shop was located in the engine room; the forge was first placed upon the deck and then upon the ice; the card room was placed at the disposal of the tinsmiths; and the saloon was reserved for shoe making, sail sewing and various minor employments.

Thus there was nothing, from the most delicate instruments to wooden shoes and ax handles, that could not be made on board. When the stock of sounding lines ran short, a rope walk was installed. The windmill, designed to run the electric light dynamo, was set up at the bow. It was not difficult to find for everyone on board some occupation which, while giving him plenty of exercise, prevented him from finding the time hang heavy on his hands. The ship and rigging had to be taken care of, the sails and ropes inspected; it was necessary to visit the hold to get provisions for the cook; and fresh water ice had to be obtained every day for the needs of the ship. Work never failed in the various shops. As for Nansen, he devoted his time to scientific researches that particularly interested him.

And so the days passed, life on board pursuing its monotonous course, and the Fram, at the will of the winds, advancing or receding with the ice floe in all directions. Of drift toward the north or of currents, there was no trace. On January 4, Nansen writes: "I am in good humor, although we are drifting again toward the south. After all, what matter? Perhaps science will gain just as much thereby, and I suppose that at the bottom this desire of reaching the pole is a suggestion of the demon of vanity." He analyzes the situation as follows: "All my calculations, with one exception, have been found correct. In spite of unfavorable prognostics, we have followed our route along the coast of Asia. We have got farther north than I dared to hope and as far east as I wished. We have been, as I desired, imprisoned in the ice. The Fram has withstood the strongest pressures without a tremor. . . .

AN OBSERVATION WITH THE THEODOLITE.

In one single point my calculations have been found defective, and, unfortunately, in one of the most important points.

"I had supposed a polar sea of slight depth—the greatest depth found in these regions being that of 146 meters obtained by the Jeannette. In such sea of slight depth I had supposed that all the currents would have an appreciable influence, and that in particular the currents formed at the mouths of Asiatic rivers would be found strong enough to push the ice toward the north. Now, I found a depth that my sounding lines could not measure, and that I estimate to-day at 1,800 meters at least, and perhaps double that. All my faith in the existence of a current is thus reversed. There is none, or else it is an extremely weak one. My sole hope now is in the winds. Christopher Columbus discovered America in consequence of a false calculation that was not even his. Heaven knows whither my error may lead us. Only, I again repeat that the Siberian driftwood found upon the coast of Greenland cannot lie, and we must follow the route that it has taken."

A few days later on, again discouraged, although the eightieth degree was reached, Nansen made a not very

A SOUNDING OF 3,850 METERS.

reassuring calculation, from which it resulted that at the rate at which the Fram had advanced up to then, it would take no less than four years to reach the pole and eight years to return to Norway.

The great event of the beginning of the following year was the return of the sun, which was preceded by a strange mirage. It was on February 16 that the image of the sun appeared for the first time.

A wide band of brilliant red fire first showed itself on the horizon. A moment afterward there were observed two similar bands superposed and separated by a darker interval. Finally, at the end of a few instants, there could be counted five of these bands of equal length. The whole gave the impression of an extraordinary rectangular sun of a red tint divided into horizontal bands that were alternately pale and dark. The sun which thus announced its approaching return was still, at midday, at 2° 22' beneath the horizon. Ten days afterward it finally emerged, and on April 6, Nansen, Scott-Hansen, and Johansen were enabled to observe an eclipse of it.

A few days after writing in his journal this somewhat splenetic phrase, "Upon our return, we shall have nothing to relate," he was formulating to himself for the first time the great project that was beginning to haunt him. "Peter Henriksen and I have taken a long walk in a N. N. E. direction. The ice was smooth and flat, and perfect for a sledge. It would be possible with dogs and sledges to go upon this ice as far as to the pole, on condition of abandoning the ship without any hope of finding it again, and to beat a retreat, when the moment of returning came, in the direction of Francis Joseph Land, Spitzenberg and Greenland." Nine years had been devoted by Nansen to the maturing of his plan of polar expedition, which was born wholly of logical deductions. During the entire year of 1894 he was weighing the pros and cons of his project of a sledge journey to the pole, the execution of which was to occur in the spring of 1895.

With the beginning of spring, Nansen and his companions had the satisfaction of ascertaining that the progress of the Fram's drifting was not quite so slow as during the winter; but, upon the whole, it was always the same sort of locomotion, the ship advancing after the fashion of a crab. As soon as it made a point in advance, a retrogression followed. What was singular was that, during the entire drifting, the bow of the Fram was turned toward the south.

On May 1 the vessel was in 80° 46' of north latitude. At the end of June it had reached 81° 52'. Then a contrary wind set in, and at the end of summer (September 5) the ship was in 81° 14', after traversing, from the beginning of the month of May, more than six degrees of longitude from east to west.

Deceived in his hopes of a regular drift, Nansen had for a long time endeavored to explain the resistance that the ice floe seemed to experience, and the reactions that it underwent by the existence of a land more southerly than any that had been discovered before him in these parts. He thought several times that he recognized by repeated signs that such land was near. But none of the indices that had at first appeared convincing was verified. On the contrary, one positive fact absolutely indicated that if there was a land at the north, it could not be near. Convinced before his start that the polar sea was uniformly of slight depth, Nansen had not provided himself with sounding lines of great length. Now, since the entrance of the Fram into the ice floe, he had not, with the means at his command, been able to find bottom. So, at the end of winter, he decided to sacrifice one of the steel cables of the ship in order to make a sounding of the depth required. Space was not wanting on the ice for establishing a rope walk. The cable was unwound and a thin, flexible line of four or five thousand meters was obtained. After this it was possible to make soundings, and Nansen did not cease to find depths greater than 3,300 meters and reaching 3,900.

Long and frequent excursions were made by Dr. Blessing, the ship's surgeon, in search of algæ, and by Dr. Nansen, who, occupied as he was with his scientific work of the moment, was continuously thinking of the sledge journey that he had projected for the following year.

During the month of April the ice floe was exceptionally practicable for sledges and for men provided with snow shoes.

In May, numerous breakages were caused by the wind and gave rise to so many channels or crevices. In June the surface became very bad.

With the beginning of July quite a strong pressure occurred, as if to recall to Nansen that it was in the midst of summer that the Jeannette was crushed. At the same time, the surface of the ice became worse again, and neither ski nor snow shoes were able to sustain those who ventured upon it. In all the depressions of the ice there then formed large lakes of fresh water by which the Fram was surrounded. There was one on the starboard side large enough to permit boating parties to sail or row upon. So, boating became the pastime of the evenings—those evenings of the polar summer that do not end in night.

The seasons succeeded one another, and Nansen's decision was made. At the end of the winter of 1894-95, with his dogs, sledges and kayaks, he would leave the Fram and push as far as possible straight for the pole. The second wintering of the Fram was devoted to organizing the new expedition. After consulting Sverdrup, and after mature reflection, Dr. Nansen selected Johansen for his traveling companion in his voyage toward the pole.

The construction of kayaks, the selection of the most practical clothing, the determining of the nature and quantity of provisions to be carried, etc., such was the work that thereafter occupied every moment of the members of the expedition.

On the 13th of December, the latitude of 82° 30' had been reached, and the Fram had beaten the record; only 833 kilometers (500 miles) separated her from the pole on that day. On the days that followed, the Fram experienced more and more violent shocks, and formidable pressures occurred around her, while still more formidable ones were to come.

Early on the morning of January 3 there were heard grindings and crackings as if the pressure was beginning. A huge pressure ridge was observed along the channel on the larboard side at scarcely thirty paces from the Fram, and on this side fissures extended to within less than twenty paces of the vessel.

All the spare objects that were upon the ice, such as planks, beams and other things that were useful, were hoisted to the deck. Just before noon, the pressure suddenly began again and the Fram's situation became alarming. During the afternoon preparations were made for leaving the ship should it become necessary.

On the 4th of January, after a relatively calm night, the pressure resumed its work. The entire effort of the ice seemed to be directed against the Fram, which, unfortunately, did not detach herself from the bed in which she lay. So the piled up ice towered above and threatened to fall upon her. On the 5th the situation had not improved. The rumbling and roaring noise of the pressure continued without intermission.

The mountain of moving ice on the larboard side of the ship leaned more and more and spread pieces of ice and a large amount of snow over the deck.

During this time the men began to pack bags and valises. It was not necessary to urge them, for the ice took it upon itself to do that by rumbling along the sides of the vessel. There was a terrible hubbub in the darkness, which was so much the more intense in that, to crown the whole, the lights had been allowed to go out in the general confusion.

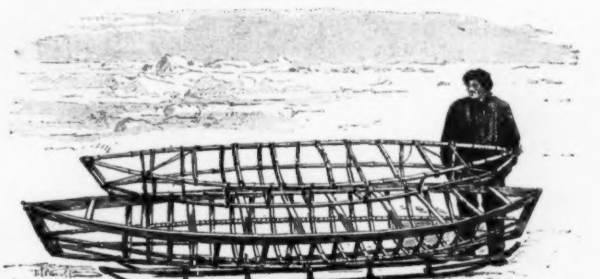
The saloon, the berths and the deck were soon freed from bags, and the crew began its walk upon the ice.

The noise made by the ice in its attack of the ship's hull was such that the men could scarcely hear each other speak; but everything was soon in safety.

While the men were dragging their bags along, the pressure finally ceased and all became quiet. But what a spectacle! The larboard side of the Fram had nearly disappeared under the snow. The danger was averted, but while it was impending it made things lively. Nansen and his companions decided to leave thereafter, as long as winter lasted, their provisions, equipments, sledges, kayaks and instruments upon the large hummock. The Fram had certainly proved that her strength was really exceptional and in her situation no other ship would have resisted. But Nansen was right in thinking that "however conscious one may be of his own strength, it is well to respect such an antagonist as ice."

For the above particulars and for our engravings we are indebted to L'Illustration.

NANSEN ADDRESSING THE MEMBERS OF THE EXPEDITION.



SKELETONS OF KAYAKS UPON HAND SLEDGES.

CHAMBER MUSIC IN THE SALOON OF THE FRAM.

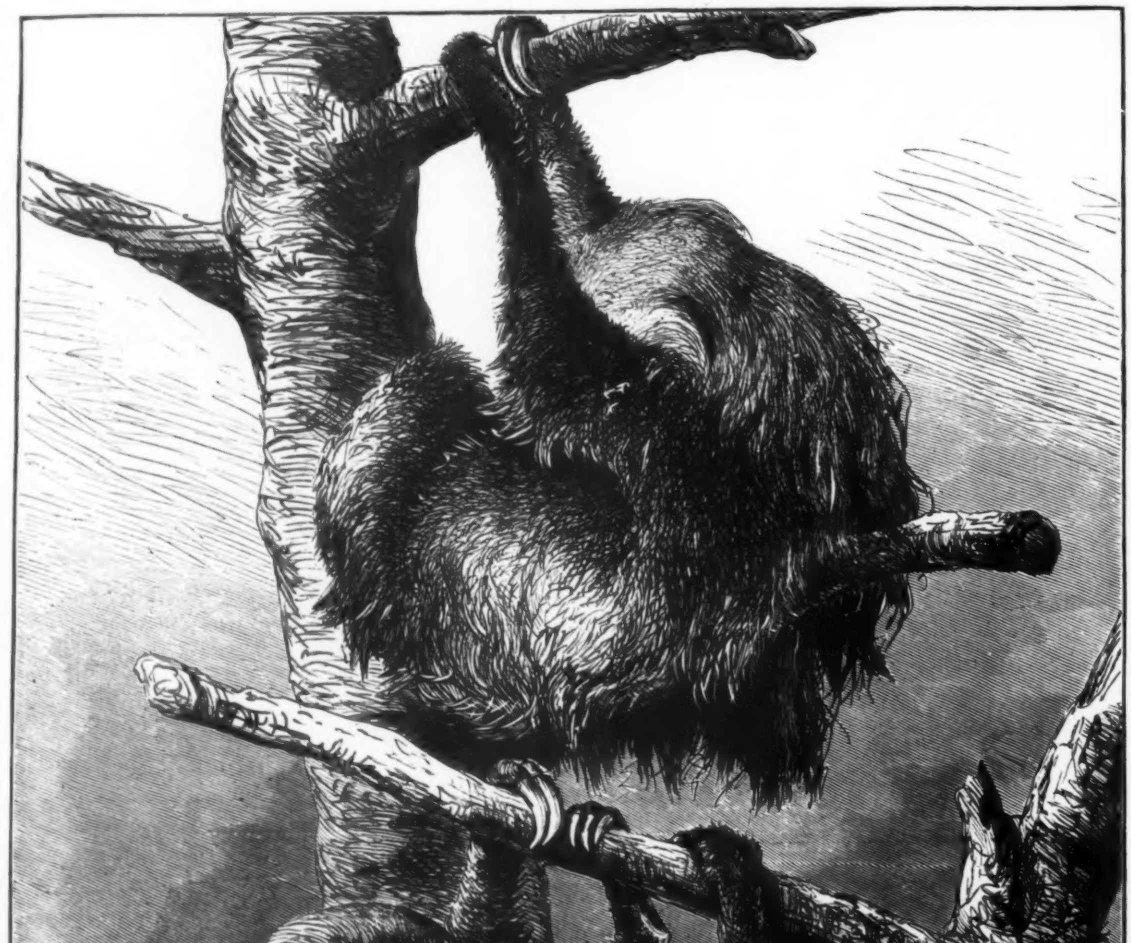
OBSERVATION OF THE BAROMETER.

The largest organ in the world is that in the town hall at Sydney. It was built by Messrs. Hill & Son, of London, at a cost of $75,000, and occupied about three years in building. Since its erection at Sydney it has been altered somewhat by changing the pitch, character, and position of some of the stops; two new stops have been added to produce thunder and chime effects, and the pipes of the choir and solo organs have been inclosed in swell boxes, with the exception of three solo stops at a high pressure of wind. These and other items bring the total cost to $80,000. The instrument has five manuals and pedals, 33 thumb pistons, other necessary accessories, and 146 stops, including couplers and tremulants. The longest pipe has a speaking length of 64 ft. The blowing apparatus is worked by a gas engine of 8 horse power. The organ occupies a width of more than 80 ft. and a depth (from front to back) of 26 ft.

THE SLOTH.

BOTH the family and generic names of the sloth, tardigrada and bradypus, are derived from the extreme slowness of its movements. It has been asserted that it takes not more than fifty steps a day, requiring a month to traverse a mile. The fore feet have either three or two toes and the hind feet three toes, and all the toes end in long curved claws, channeled underneath, the bones firmly united together and the claws turned in against the soles. Their progress on a level surface is very awkward. The hair is dry, harsh and coarse, and the tail is very short or absent.

The sloths were considered by the early naturalists as imperfect and deformed creatures, but in the trees, their natural home, their peculiarities of structure are as admirably adapted for their convenience and enjoyment as in any other animal. The fore limbs have great freedom of motion, and all are so constructed that by means of the claws they suspend themselves to the branches and hang for a long time, and even sleep, back downward, as shown in our illustration, for which we are indebted to the Zoologische Garten, Leipzig. They are rarely seen on the ground, as they can pass from one tree to another by the interlocking branches for miles in the thick forests of South America, where they are only found. They are rarely more than two feet long, and their hair resembles in color the bark of the trees upon which they live; their food is entirely vegetable, the leaves and twigs of trees. They have only one young at a time, which clings to the mother, hiding among the hair. The native name is ai, from their feeble, plaintive cry. They are remarkably tenacious of life and apparently unconscious of pain. If by chance the sloth ascends a tree too remote from another tree to admit of passage across, the natives say that it rolls itself in a ball and drops to the ground, its thick, wiry hair rendering such a fall comparatively harmless. From its habits it can rarely ever drink. Its flesh and skin are useless.

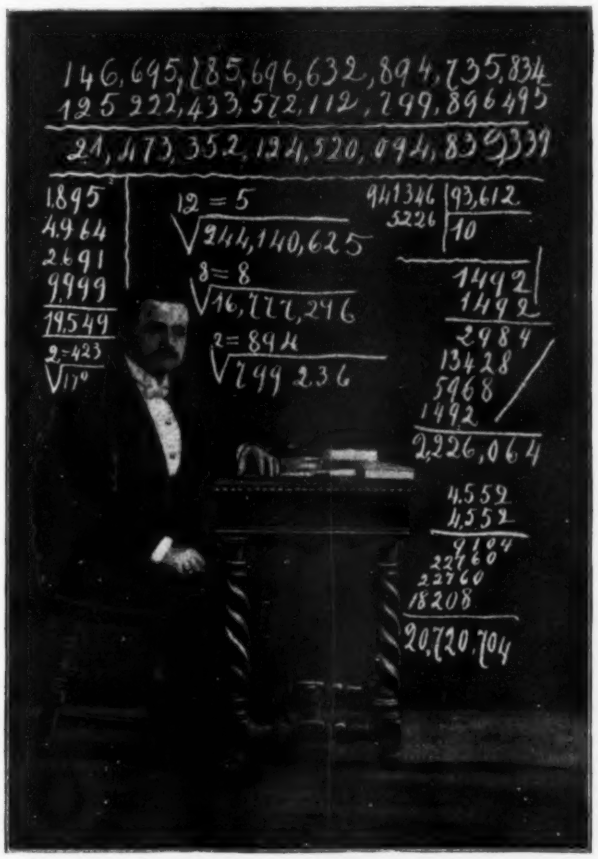


A SLOTH FAMILY.

Plans have been devised by a prominent firm of Western American last manufacturers which are almost Jules Vernesque in their startling originality and audacity of conception. These plans call for a traveling last factory complete in the most minute details, and include a train of four cars built expressly for this purpose, and fitted up in a manner calculated to meet the most exacting demands. The train will consist of a combined dining and sleeping car for the employes, a model maker's car, a third car for the turning lathes, platers, polishers, grinders, etc., while the fourth will carry a supply of rough turned last blocks. It is intended that the train will visit all the principal shoe centers of the country.—Shoe and Leather Record

THE FIGURE GENIUS JACQUES INAUDI.

WE publish herewith an engraving (for which we are indebted to the Illustrirte Zeitung) of Jacques Inaudi, the "lightning calculator" who gave most astounding proofs of his skill in handling mathematical problems without the assistance of pencil and paper to a circle of savants in Leipzig. He is a Piedmontese and until he was sixteen years old was a shepherd, but his gift soon made him a psychological wonder exciting the interest of the scientific world. When numbers are called out by the people in an audience, they are written on a blackboard behind his back for the benefit of the audience, but Inaudi adds, subtracts, multiplies and divides them correctly in an instant, without seeing them. The subtraction of numbers consisting of twenty-four figures is an easy matter for him, and he will name the figures forward or backward, or single figures separately, without any mistake. Problems for which logarithm tables are generally used he solves mentally with wonderful precision. He will give the age of a person to the second. For instance, he asked a man, "When were you born?" The answer was, "On December 11, 1856." "Then you were born on Thursday," he answered immediately, "and you are 40 years, 1 month, and 18 days old; you have lived 2,093,120 minutes or 1,265,587,200 seconds!" Jacques Inaudi is unique; problems that would leave the normal mind puzzled and weary, his calculating apparatus solves with astonishing ease and accuracy. He never shrinks from long columns of figures nor the most difficult problems.



JACQUES INAUDI, THE LIGHTNING CALCULATOR.

ON THE PROGRESS OF CHEMISTRY AND THE CHEMICAL ARTS DURING THE QUEEN'S REIGN.*

By Professor THORPE, LL.D., F.R.S., in Knowledge.

CHEMISTRY as an art has been practiced from time immemorial, and a great variety of what are, strictly speaking, chemical products, such as metals, salts, acids, dyes, pigments, were made long before the Christian era. Chemistry as a science, however, is barely a century old. It is based upon the atomic theory, and the idea of explaining chemical phenomena by means of the conception of atoms, foreshadowed by Newton, and more clearly adumbrated by his followers Kiel, Hartley, Marzucchi, and Higgins, was first definitely stated by John Dalton during the first decade of this century. The whole course of modern chemistry, however complex and many sided it may seem, is really one vast elaboration of the atomic theory. As Liebig has said: "All our ideas are so interwoven with Dalton's theory that we cannot carry ourselves back to the times in which that theory did not exist." And yet this fundamental hypothesis, as understood by chemists, had barely come of age when the Queen came to the throne; it was not much older at the time than she herself.

The illustrious philosopher who first gave precision to this idea was still living, but stricken down at the time by the paralytic attack, the beginning of the brain disintegration which seven years later ended in his death. Sir Humphry Davy—a younger man than Dalton—the pioneer in the then recently discovered field of electro-chemistry, and which to-day is yielding such splendid fruit, had been dead only about eight years, as were Wollaston and Thomas Young. All three, in fact, died at about the same period, and all from affections of the brain. At the Royal Institution he who has been styled the greatest of Davy's discoveries reigned in Davy's stead. Michael Faraday of revered memory — blacksmith's son, newspaper boy, bookbinder's apprentice, and Fullerian professor of chemistry — was then in his forty-fifth year, in the full maturity of his intellectual power, and near the meridian of his scientific glory. All his more important work in chemistry—his discovery of benzene, his researches on the liquefaction of the gases—had been accomplished, and he was almost wholly engaged upon those great problems of electrical science which have made the extraordinary development of applied electricity, as we see it to-day in electrolytic decomposition, in the electric light, and in the application of electricity as a source of power, alone possible.

The Queen, in fact, may be said to have witnessed the birth of this marvelous application of natural energy, to have lived with it through its vigorous youth, and to have seen the promise of a fruition so vast that no man can set bounds to it. Think of the simple experiments out of which has grown the mighty machinery of modern industrial electricity! Try to realize the difference between Faraday's simple homemade apparatus—his small copper disks, his bits of soft iron wound with wire insulated with calico and twine—and the mighty dynamos which are converting the energy of a "harnessed" Niagara into heat and light and chemical action, and supplying power to a continent! And all this within the span of a single reign—within the compass of a couple of generations. This astonishing movement is what historians will ever recognize as the characteristic feature of the Victorian era. It has wholly changed the economic and social condition, not only of our people, but of every country which has had the intelligence and the wisdom to participate in it, or the sagacity to avail itself of its fruits. It has reacted not only upon industry, but on every department of intellectual effort. It has changed, although hardly with a commensurate rapidity—for there is no class so conservative as that of the schoolmaster—the face of our educational system. To judge what the change has been, let us try to realize how chemistry was taught in this country in 1837. As a part of school education it was practically unknown, although children whose parents had the good fortune to be influenced by the teaching of such farsighted men as Mr. Edgeworth had their curiosity stimulated and fed by occasional lectures on science.

As regards the older universities, at Oxford there was Dr. Daubeny, an amiable and accomplished gentleman, who was a professor of botany to chemists and a professor of chemistry to botanists; at Cambridge, there was Professor Cumming, who lectured on chemistry, but interested himself mainly in electricity. At neither place was there anything in the nature of a laboratory which the student could attend. If the enterprising undergraduate desired to familiarize himself with the facts of chemistry by practical experiment, or sought to try and work out an idea which might have occurred to him, he had to pursue his inquiries in his own rooms and with such apparatus as his means or his opportunities could command, to the imminent risk of his furniture and to the dismay and disgust of his bedmaker. It was under such conditions that the late Sir John Herschel discovered the solvent action on silver salts unacted upon by light of what the photographers know as "hypo" (sodium thiosulphate), and thereby made photography possible.

In Scotland, Dr. Hope—whose name carries us back to the days of phlogiston—still enjoyed at Edinburgh the fame as a lecturer which he shared with Davy at the Royal Institution; but no tuition in practical chemistry, as a part of university training, was ever thought of. Matters at Glasgow were a little better, and Thomas Thomson would occasionally extend a brusque hospitality to the student who aspired to the art and mystery of mineral analysis, but no systematic instruction was ever attempted.

The youth with no knowledge of manipulative work, and with scarcely an acquaintance with the forms even of chemical apparatus, was regarded as a sort of laborant, and might be set at the very outset to struggle with a zeolite, or to grapple with an atomic weight determination, as best he might. This circumstance probably serves to explain the character of much of the analytical work which is connected with Thomson's name, and which, happily enough, has passed into oblivion.

In London there was the promise of better things. Thomas Graham—who had already made his memorable discovery of the law of gaseous diffusion while professor of chemistry at Anderson's College, in Glasgow, where he had established a school of practical chemistry, and where he had as students the late James Young, whose name is linked with the creation of the Scotch paraffin oil industry, and the present Lord Playfair—had followed Ure and Birkbeck to London, and had been elected to the chair of chemistry at University College, Gower Street, up to that time known as the University of London. Here as successor to Edward Turner, a painstaking and even brilliant manipulator whose atomic weight work rivals that of Berzelius in point of conscientious accuracy, he created the school of chemistry which, aided by Fownes and Williamson, he made famous throughout Europe.

But it may be doubted whether in 1837 there were more than a couple of dozen persons altogether in the British Isles receiving systematic instruction in practical chemistry, and even that supply was probably fully equal to the demand. There was, in fact, little to tempt men to take up the study or practice of chemistry as a means of livelihood. Professorships or teacherships were few in number and poorly paid; analytical chemistry, as a profession, barely existed, although the "expert," pace Ure, was not altogether unknown; and chemical manufacturing was, for the most part, in the hands of men to whom chemistry was an empirical art.

How things appeared to an intelligent and keen observer is well illustrated by one of Liebig's letters to Berzelius, in which he recounts his impressions of England, which he had just visited. Under date November 26, 1837, Liebig tells the Swedish chemist that he had been some months in England, had seen a vast amount, and learned little. England, he says, is not the land of science; her chemists are ashamed to call themselves chemists because the apothecaries had appropriated the name. He was extraordinarily pleased with us as a people and delighted with our hospitality and welcome, but as regards our chemists—well, Graham was the only exception, and he was precious. Liebig evidently considered that Faraday could no longer be reckoned among the chemists.

But a little leaven was leavening the whole lump, and that leaven was Liebig himself. Aided by the farsighted munificence of a German prince, he had succeeded in establishing the little Giessen laboratory, and thither every seeker after chemical truth and every aspirant for chemical fame bent his steps. Among these early chemical pilgrims were Lord Playfair, Sir Henry Gilbert, Prof. Williamson, Dr. Gladstone—all happily still among us. Others might be named, but the greater number have now passed away. All of them, whether great or small, brought back from Giessen something of the spirit and method which have made the little laboratory on the banks of the Lahn famous in the history of chemistry. The influence of Giessen has been as a seed which, falling on good ground, has sprung up and multiplied a hundredfold. That influence has made Germany pre-eminent in the world of scientific chemistry and may make her pre-eminent, if it has not already done so, in the world of industrial chemistry.

Luckily for this country, Liebig's influence has reacted also upon us. It has had a profound effect on chemical activity and on the development of chemical teaching in England. One of its first results was seen in the founding, in 1841, of the Chemical Society, whose duty and privilege it is to foster chemical inquiry and promote the spread of chemical knowledge. The society now numbers upward of two thousand members. How it is achieving its purpose may be seen in the activity and interest of its meetings, in the extent and value of its publications, and in the helpful hand it extends to the investigator by the prudent administration of the funds which have been placed at its disposal by the munificence of private benefactors and public bodies.

Another notable result of Liebig's influence on chemistry was seen in the foundation, in 1845, of the Royal College of Chemistry, of which Hofmann, one of his most distinguished pupils, was invited to take charge—thanks largely to the action of the late Prince Consort. What Hofmann, fired by the example of Liebig and his own innate enthusiasm, did for chemistry in England may be seen in the panegyric of Hofmann—the joint work of Lord Playfair, Sir Frederick Abel, Dr. Perkin, and Prof. Armstrong—which appeared some little time ago in the Journal of the Chemical Society. There is no more inspiriting or instructive chapter in the history of chemistry in this country than that which records the work of the Royal College of Chemistry, and traces its influence on the development of pure and applied science.

Although Hofmann unfortunately left us, his spirit and example still remain and actuate us. This spirit has been carried into a hundred places of chemical instruction and research in these islands. Let us pray that it may continue and increase, for it is on its continuance and growth that the development of chemical science and chemical industry depends; and in so far as our national prosperity is connected with the chemical arts our national prosperity depends on it also.

It is hardly necessary nowadays to show how closely the well-being of a community is connected with the chemical arts. Chemistry and its applications concern us at every turn, for there is scarcely a single industrial operation which could be named with which this science has not some relations, either proximately or re-

* From an address delivered at the East London Technical College, People's Palace, on the occasion of the distribution of science certificates, February 8, 1897. With additions.

motely. There is a noble passage in one of Sir Humphry Davy's earlier lectures which well illustrates this point. The lesson has been frequently urged upon us, but never more forcibly than by Davy at the very beginning of this century. It is not often that the theater of the Royal Institution resounds with more eloquent sentences than these:

"The progression of physical science is much more connected with your prosperity than is usually imagined. You owe to experimental philosophy some of the most important and peculiar of your advantages. It is not by foreign conquests chiefly that you are become great, but by a conquest of nature in your own country. It is not so much by colonization that you have attained your pre-eminence or wealth as by the cultivation of the riches of your own soil. . . .

"In every part of the world manufactures made from the mere clay and pebbles of your soil may be found; and to what is this owing? To chemical arts and experiments. You have excelled all other people in the products of industry. But why? Because you have assisted industry by science. Do not regard as indifferent what is your true and greatest glory. Except in these respects, and in the light of a pure system of faith, in what are you superior to Athens or to Rome? Do you carry away from them the palm in literature and the fine arts? Do you not rather glory—and justly too—in being in these respects their imitators? Is it not demonstrated by the nature of your system of public education and by your popular amusements? In what, then, are you their superiors? In everything connected with physical science—with the experimental arts. These are your characteristics. Do not neglect them.

"You have a Newton, who is the glory, not only of your own country, but of the human race. You have a Bacon, whose precepts may still be attended to with advantage. Shall Englishmen slumber in that path which these great men have opened, and be overtaken by their neighbors? Say, rather, that all assistance shall be given to their efforts; that they shall be attended to, encouraged and supported."

These words were spoken in 1809, and during all the turmoil and political disquietude that marked the opening years of the century. However willing and receptive the ears, the time was inopportune. The minds of the auditors might be convinced, but their energies were preoccupied with the arts of war rather than with those of industry and peace. A generation later, and when Europe had settled down after the fall of Napoleon, Davy's teaching began to bear fruit. We have seen how far it had matured at the time of the Queen's accession, and in the years immediately subsequent to it: how far has it been attended to and supported since?

As regards chemical education, the difference is enormous. There is not an important town in the kingdom in which chemistry is not taught, and, on the whole, well taught. Almost every manufacturing town in the country can show a public chemical laboratory far better equipped with appliances for teaching, and even research, than were the most famous laboratories of sixty years ago. In the matter of the introduction of the teaching of physical science into our schools, the force of public opinion is gradually making itself felt, although the head master, as a rule, hardly yet realizes the full significance of Faraday's weighty words when he said: "I do think that the study of natural science is so glorious a school for the mind that, with the laws impressed on all created things by the Creator, and the wonderful unity and stability of matter and the forces of matter, there cannot be a better school for the education of the mind."

Things, however, have improved since the time that Faraday told the public school commissioners that the fact that the natural knowledge which had been given to the world in such abundance was untouched, and that no sufficient attempt was being made to convey it to the young mind, growing up and obtaining its first views of these things, was to him a matter so strange that he found it difficult to understand. The opposition which Faraday felt was so difficult to overcome, but which, he added, he had not the least doubt in the world ought to be overcome, has been to some extent relaxed, and, in the curt but characteristic language of the forums, "stinks" are at least tolerated, even if they are not encouraged, in the curricula of most public schools. It is, however, in the newer provincial colleges that the teaching of chemistry has received its greatest development. Owens College, Manchester, founded more than forty years ago, has become mainly by the influence and organizing power of Sir Henry Roscoe, and of his successors, Profs. Dixon and Perkin, one of the foremost schools of chemistry in the country.

The great success of Owens College has stimulated almost every large town to provide itself with an institution of similar character; and colleges of university type, all of them with well-equipped chemical laboratories, are now to be found in Liverpool, Leeds, Newcastle, Nottingham, Sheffield, Birmingham, Bristol, Cardiff, Aberystwith, Bangor, and Dundee. Institutions of a less ambitious type, although provided for the most part with good accommodation for instruction in practical chemistry, are met with, among other places, at Bradford, Huddersfield, Preston, Oldham, Chester, Newcastle-under-Lyme, Portsmouth, Southampton, Camborne, Edinburgh, and Glasgow. All the older universities have followed suit. The university laboratory at Cambridge is one of the best arranged in the kingdom; Edinburgh is also admirably provided with the means of pursuing research in the higher branches of the science, as are the recently opened laboratories of St. Andrew's and Aberdeen. With the exception of University and King's Colleges and the Royal College of Science (into which has been merged the chemical teaching of the Royal College of Chemistry and of the Royal School of Mines, in Jermyn Street), all the more important schools of chemistry in London are comparatively modern. The City and Guilds Institute in South Kensington, built in 1883, and the associated Institute in Finsbury, erected a short time previously, owe their origin to the action of the City companies, who have been instrumental also in founding or in assisting a number of the polytechnics scattered round London, such as the Goldsmiths' Institute at New Cross, the Battersea Polytechnic, and the East London Technical College, which has its home in the People's Palace. A great number of the polytechnics and minor colleges above named are dependent upon aid from the Department of Science and Art, or are supported by funds at the disposal of County Councils. Indeed, the liberation of the "beer" money, and its very general application to so-called technical education, has had a very marked effect in diffusing a knowledge of the elementary principles of science. Whether the money is in all cases spent to the best advantage may be open to question. There is, indeed, little doubt that more real good might be accomplished by a better method of allocating the amount, as, for example, by some system of co-ordinating County Councils within specified areas, with a view of subsidizing secondary schools and the colleges of university type situated within the area. This, however, as a part of the general question of what is the best method of dealing with secondary education in this country, is too complex a matter to be dealt with now. It is pretty plain that before many more years have passed a Parliamentary inquiry will be demanded on the working of the present method of allowing each County Council to do practically what it likes with what it imagines to be its own.

No record of the educational work in science of the last sixty years would be complete without some reference to South Kensington. The system and its results have been, at times, the subject of much hostile and, it must be added, not very well informed or altogether impartial criticism. But I venture to think that any dispassionate and unprejudiced inquirer, who will take the trouble to make himself master of the subject, will be constrained to allow that the department has done great and permanent service to the cause of scientific education in this country. The general standard of scientific knowledge has been enormously increased by the hundreds of science classes created by its agency, and which otherwise would have been non-existent. How far it will be allowed to continue on its present footing remains to be seen. It is, however, certain that the science teaching which it has called into existence and which it has fostered and encouraged is too much an integral and essential part of our educational system to be abolished, whatever may be the machinery of state by which it is to be directed and controlled in future.

What Englishmen of science have done in the way of chemical inquiry and discovery during the Victorian era, the pages of the Philosophical Transactions and of the Journal of the Chemical Society abundantly indicate. The names of Faraday, Graham, Williamson, Hofmann, Frankland, Miller, Schunck, Stenhouse, Brodie, Andrews, Gladstone, Crookes, Perkin, De la Rue, Müller, Roscoe, Schorlemmer, Rayleigh, Ramsay, Dewar, are associated with experimental investigations which mark points of departure in the history of chemical progress during the last sixty years. These investigations range over every department of chemical inquiry, from the isolation of new elements—the preparation of new compounds of great theoretic and industrial importance—to the discovery of new generalizations, and the recognition of important physico-chemical laws.

As regards originality in the application of chemistry to practice, our record is hardly less brilliant, although in too many cases it has been given to other nations—and in particular to Germany—to gather the fruit which ought to have been ours. It is interesting to note that the ammonia-soda process was patented by Dyar and Hemming in the first years of the Queen's reign, and was worked by the Muspratts as early as 1839; but it was left to two Belgian engineers to secure for this method of manufacturing alkali the great commercial success which it now enjoys. The discovery of benzene by Faraday was the first step in the history of the coal tar color manufacture; the second step was taken by Mansfield, at the sacrifice of his life, in working out the industrial isolation of the hydrocarbon; while the third was due to Perkin, when, by the discovery of mauve, he revealed the enormous wealth of coloring matter which was latent in coal tar. In spite of the labors and example of Medlock and of Nicholson, the importance of this great branch of industrial chemistry was not recognized by manufacturing chemists in this country, and its present extraordinary development is due to Germany, which has spent upon it some of the ablest chemical talent it possesses. It is rather by the development and extension of well-established processes, depending on comparatively simple chemical principles, that our progress in the chemical arts is to be measured; for our staple chemical industries remain very much what they were at the beginning of the Queen's reign. The industrial chemistry of chlorine may be said to have been worked out by Englishmen, and the names of Gossage, Weldon, and Deacon are pre-eminently associated with the growth of this branch of chemical manufacture. The Muspratts manufactured Liebig's patent manure in 1843, and this marks the beginning of the large trade in chemical fertilizers which has been entirely developed during the Queen's reign. Perhaps the best measure of the progress of applied chemistry in this kingdom during the past sixty years may be gathered from the difference in the amounts of oil of vitriol manufactured in 1837 and at the present time. The great value of sulphuric acid as an index of the prosperity of the chemical arts arises from the circumstance that there is no other single chemical product that is so largely concerned in the manufacture, directly or indirectly, of other chemical substances. To-day sulphuric acid is manufactured with an almost quantitative precision, thanks very largely to the introduction of the Glover tower, which it is not too much to say effected a revolution in this great industry.

What the future has in store for us remains to be seen. The more general introduction of electrical processes into chemical manufacturing is bound to effect great changes. The application of electrical energy has completely altered the aspect of the metallurgy of aluminum copper and the alkali metals, and it now threatens the supremacy of the established methods of manufacturing alkali and chlorine.

So far as can be seen, there is no immediate hope that this country will be able to compete with Germany in the manufacture of those products which are the direct outcome of the application of the higher and more recondite branches of chemical science to industry, nor will there be even the prospective hope until our manufacturers, as a body, bring the spirit of science into their work, and show a greater receptivity and a more widespread desire to turn the ever-growing development of the science to practical account.

SELECTED FORMULÆ.

Puncture Cement.—A recent patented preparation for the automatic repairing of punctures in bicycle tires consists of glycerin holding gelatinous silica or aluminum hydrate in suspension. Three volumes of glycerin are mixed with one volume of liquid water glass, and an acid is stirred in. The resulting jelly is diluted with three additional volumes of glycerin, and from four to six ounces of this fluid are placed in each tire. In case of puncture the internal pressure of the air forces the fluid into the hole, which it closes.

Polish for Ax and Pick Handles.—

(1.)	Yellow wax	125 parts
	Hard soap	30 "
	Glue	60 "
	Soda ash (80°)	125 "
	Water and whiting, a sufficient quantity.	

Dissolve the soda in 2,000 parts of water; add the wax; boil down to 1,250 parts, and add the soap. Dissolve the glue in 500 parts of water by the aid of heat; stir in the whiting, and mix the whole with the solution of wax and soap.

(2.)	Beeswax	½ pound
	Yellow soap	¼ "
	Water	5 pints

Boil to a proper degree of consistence, with constant agitation, then add boiled oil and spirit of turpentine, of each, ½ pint. For use dilute with water.

(3.)	Wax	4½ ounces
	Soap	½ "
	Spirit turpentine	½ pint
	Boiling water	½ "

Melt the wax in a covered jar by gentle heat; add the turpentine carefully, and then gradually add the soap, previously dissolved in the water, and stir until stiff.—Pharmaceutical Era.

Combined Toning and Fixing Bath.—Dr. Vogel recommends the following combined bath as of special value for aristo and gelatine papers; it will keep and may be used repeatedly (after filtration) until exhausted:

Distilled water	400 c. cm.
Hyposulphite of soda	100 g.
Sulphocyanide of ammonium	11 g.
Acetate of lead	4 g.
Powdered alum	3 g.
Citric acid	3 g.
Nitrate of lead	4 g.

This solution is allowed to stand for some days; it is then filtered and mixed with a solution of chloride of gold (1 to 100) 25 c. cm.

The prints are toned until they assume the desired color.

Dr. Liesegang recommends the following formula:

Water	800 g.
Hyposulphite of soda	200 g.
Sulphocyanide of ammonium	25 g.
Acetate of sodium	15 g.
Saturated solution of alum	50 g.

A few cuttings of unfixed paper are placed in the solution and left to settle a few days; it is then filtered and completed with

Water	200 g.
Chloride of gold	1 g.
Chloride of ammonium	2 g.

Sulphocyanate toning baths are, according to Edward Valenta, largely used in Europe to tone aristotypes, as they work evenly, and give all gradations of tone from a violet purple to a dark blue black. Following is one of the best known formulæ:

I.

Distilled water	1000 c. cm.
Fused acetate of sodium	40 g.
Chloride of gold solution (1 to 100)	100 c. cm.

II.

Distilled water	1000 c. cm.
Sulphocyanate of ammonium	40 g.
Chloride of gold solution (1 to 100)	100 c. cm.

These stock solutions keep for a long time, if well corked, but should not be used until twenty-four hours after mixing.

For use,	No. 1	50 c. cm.
	No. 2	50 "
	Distilled water	100 "

A somewhat similar formula to the above is recommended by one of the leading specialists on account of its hardening action upon the collodion films:

I.

Distilled water	800 c. cm.
Sulphocyanate of ammonia	15 "
Alum	15 "
Carbonate of ammonium	1 "

II.

Distilled water	600 c. cm.
Chloride of gold	1 g.
For use, No. 1	100 c. cm.
No. 2	50 "

—American Journal of Photography.

To Clean Bronze Articles.—According to the Antiquitaten Zeitung, articles of bronze are best cleaned by the use of a paste made of powdered chicory and water. The paste is spread over the bronze and rubbed well over the surface by means of a stiff brush (an old stiff tooth brush will answer), and then allowed to dry on the article. After drying rinse off the powder with running water, and dry in the sun. Wiping off with an oiled rag will improve the looks of modern bronzes.

Liquid Renovator for Enameled Leather.—Ingredients:

Paraffin oil	48 parts
Oil of lavender	1 "
Essence of citronelle	1 "
Spirits of ammonia	2 "

Method of preparation: Mix all together, and shake the bottle well before using, laying on a coating with a sponge, and polishing with a soft cloth or leather afterward.

ENGINEERING NOTES.

The new roller bridge which crosses the Charles X basin of the port of Cherbourg, France, has been constructed by Bon and Lustremant, of Paris, says the Trades Journals Review. The bridge, built of steel, has a length of 180 ft. and a width of about 17 ft., and serves for ordinary and rail traffic. When it is to be withdrawn, the central plunger first lifts it 33 in. Then the hydraulic rams, placed under the bridge in the usual way, come into play, and pull the bridge by means of chains. The bridge rests on a sort of double bogie. There are on each side two pairs of wheels bearing a cross piece, about the horizontal axis of which the whole bridge oscillates. We have thus a bogie allowing of motion, not in a horizontal, but in a vertical plane. This is the interesting feature of the bridge, which otherwise, and in its hydraulic machinery, does not differ from the usual constructions. When in the lower position, at which the track is on a level with the track on shore, the bridge rests on iron shoes. The main vertical ram has a diameter of 36·41 inches, the two horizontal rams diameters of 14·2 inches; the thicknesses of the cylinder walls are 2·6 and 6·3 inches.

In the report of Inspector McDevitt on the recent large fire in Philadelphia, he says that "some idea could be formed at this fire of the possibility of, and danger from, a lateral spread of heat, which in this case extended to points nearly 200 feet away. This is more likely to occur in a wide than in a narrow street, as with the latter the inward current is so swift that the heat is carried rapidly upward. In noting the damage done to the city hall, it may be well to state that there are, perhaps, very few who have considered the danger to which the public buildings are exposed from their surroundings. On several sides of the structure there are points where it is possible for a fire to assume such headway and magnitude as that experienced in the recent fire, and from which the heat given off might leave the exposed side of the hall a crumbling mass of marble. A slight illustration of this possible result was seen during this fire by the destruction of the glass in the windows of the hall from heat generated 200 feet away, although the wind was blowing in the opposite direction. It would, therefore, seem as if some precautionary measures ought to be taken by the authorities to meet this possible danger, which at certain points is capable of doing even greater damage than that just experienced."—Fire and Water.

The total length of narrow gage light railways in Germany, including those in operation, under construction and authorized, is as follows: In the kingdom of Prussia, 3,234 kilom. (2,009⅛ miles), of which 1,342 kilom. (834 miles) constitute exclusively passenger lines, and 143 kilom. (89 miles) those for goods only, while on 1,749 kilom. (1,087 miles) both passengers and goods are carried, the motive power being horses on 881 kilom. (547 miles), steam locomotives on 1,964 kilom. (1,220 miles), electric motors on 306 kilom. (190 miles), partially horses and partially locomotives on 31½ kilom. (19½ miles), partially horses and partially electric motors on 50 kilom. (31 miles), while rope traction is adopted on 1½ kilom. (1 mile). The largest system of narrow gage lines, 782 kilom. (486 miles), is in Pomerania, after which comes the city of Berlin with 514 kilom. (319 miles), and then the provinces of Rhenish Prussia with 438 kilom. (272 miles), Posen with 308 kilom. (196 miles), Saxony with 220 kilom. (136 miles), Silesia with 218 kilom. (135 miles), and Brandenburg with 209 kilom. (129 miles), while light railways have received the least extension in the provinces of East and West Prussia, with 15 kilom. (9 miles) and 28 kilom. (17 miles) respectively. As to the states of the German confederation which are not Prussian, where the idea of narrow gage lines does not exist in the sense of the Prussian law, the official report only gives those railways which are not contained in the statistics of the state railway administration. As a rule these are city tramways, of which Hamburg had at the beginning of the present year a length of 99 kilom. (61 miles), Bavaria 85 kilom. (53 miles), and the whole of the confederated non-Prussian states, except the kingdom of Saxony, for which no statistics are available, 479 kilom. (297 miles).

The Railroad Gazette gives the wheel tests in use at the Altoona shops of the Pennsylvania Railroad. The inspector selects three wheels for testing. One wheel is placed flange downward in an anvil block weighing not less than 1,700 pounds, set on rubble masonry 2 feet deep, and having three supports not more than 5 inches wide, for the flange of the wheel to rest upon; it is struck centrally upon the hub by a weight of 140 pounds, falling from a height of 12 feet. Should the wheel break in two or more pieces after twelve blows or less, the 100 wheels represented by this test wheel are rejected. Should the wheel tested stand twelve blows without breaking in two or more pieces, the 100 wheels represented by it are regarded as satisfactory as to this test. The other two wheels must each be tested as follows: The wheel must be laid flange down in the sand, and a channel way 1¼ inch wide and 4 inches deep must be moulded with green sand around the wheel. The clean tread of the wheel must form one side of this channel way, and the clean flange must form as much of the bottom as its width will cover. The channel way must then be filled to the top with molten cast iron, which must be hot enough when poured so that the ring which is formed when the metal is cold shall be solid or free from wrinkles or layers. The time when the pouring ceases must be noted, and two minutes later an examination of the wheel must be made. If the wheel is found broken in pieces, or if any crack in the plates extends through the tread in either of the wheels tested, the 100 wheels represented by the two test wheels will be rejected. Some wheels under this test burst with some violence before the metal has become solid, throwing the molten metal some distance. As it takes about one minute for the metal to solidify, it is well to use a little precaution for that time. In order to avoid spitting during pouring, the tread and inside of flange of the wheels submitted to the thermal test should be covered with a coat of shellac. Wheels which are wet or have been exposed to snow or frost may be warmed sufficiently to dry them or remove frost before testing, but under no circumstances must the thermal test be applied to a wheel that in any part feels warm to the hand.

ELECTRICAL NOTES.

An electric omnibus, which goes four miles in half an hour, is now running in the London streets.

According to the Echo des Mines, of Paris, a telephone wire has recently been stretched across the Wallenstadt Lake, in the Canton of St. Gall, Switzerland, the span between the towers being 7,900 ft. The wire is of steel and is 2 millimeters (0·08 in.) in diameter.

A novel electric train went north on High Street about 10 A. M. over the lines of the Columbus Street railway. It consisted of the sand car and one of the construction cars, both loaded with household goods, stoves, beds, carpets and all manner of requisites for housekeeping. Inquiry developed that the goods belonged to Mr. Wolfe, one of the faithful employes of the company, who has been living on Oak Street, near the Rose Avenue sheds, but has been given the occupancy of the house at Olentangy Park owned by the company. The train of two cars furnished an admirable means of making the transfer.—Columbus (O.) Dispatch.

There are means of getting at a fire even if it is on the top floors of a 150 foot building. Electric pumps could be used at any altitude, and the motors could be kept running a long time if necessary. The desirability of keeping the electric light service going is also pointed out; the use of an electric elevator in carrying up a line of hose instead of dragging it up the stairs being obvious. The Electrical Engineer has heard it suggested that lines of water pipe should be hidden under the cornices of these tall buildings, the valves to be released electrically at the moment of need, so that flames from outside encounter a complete water sheet which keeps them off. This would doubtless hold good temporarily or until wires or pipes gave way.

A large water power scheme is projected by the Southern Californian Power Company, of Redlands, California, says Engineering News. The plan is to develop power from the Santa Ana River, by taking the water out at the junction of Bear Creek and Santa Ana River, carrying it in a cement conduit and tunnels about four miles, thus securing a fall of 1,000 feet to 1,100 feet, and then running the water again into the stream. The power will be transmitted by pole line seventy-five miles to Los Angeles, and this is to be the longest line and to carry the highest voltage, 30,000 volts, in the world. The line will run through San Bernardino, Pomona, Ontario and Pasadena, and will be able to supply all power needed in these towns. It is proposed to deliver power in Los Angeles by January, 1898.

An ingenious machine has been devised by a manufacturing company of Pittsburg, U. S. A., for truing up electric tramcar wheels which have become flattened on the tread by the action of the brakes. This machine is a simple one and very rapid in its operation. It is not necessary to remove the wheels from the trucks to true them. The car is simply run into the shops, placed in position over the machine. The wheels to be trued are jacked up and centered on the axle, and the motor controlling them started. Emery grinding wheels are then moved into position, and started in the opposite direction to the car wheels. In eleven to thirteen minutes after the car has been placed on the machine it can be on the road again with wheels that are absolutely true.

The Swan Incandescent Electric Light Company, of 14 White Street, New York City has applied to the Supreme Court for the voluntary dissolution of the company. The following directors united in the application: Mayor W. L. Strong, Edwin Einstein, Emanuel Einstein, David L. Einstein, Charles W. Spear, Morris Tatman, and Felix Samson. The company was incorporated in 1882, with a capital stock of $800,000, to manufacture and sell electric lamps under the patent of Joseph W. Swan. From 1885 until two years ago the manufacture was carried on by a licensee, the Swan Lamp Manufacturing Company, of Cleveland, O., and the only source of revenue was the royalty. Two years ago the licensee discontinued business, and since then the company has had no income. It was unable to begin the manufacture on its own account now and, as the patents expire this year, the directors deemed it advisable to wind up the company. It has no liabilities, and assets $6,903 in cash, patents, and a safe.—New York Sun.

The fire danger lurking in electric flexible cord connections is practically demonstrated every now and then, and with it, too, the need of better cords. In a recent instance mentioned in a fire underwriter's report, a flexible cord, supporting a lamp which was not burning at the time, suddenly developed, says Cassier's Magazine, a short circuit and a one ampere fuse in a rosette opened, cutting off the current. The cord was quite greasy with oil coming from shafts and bearings, and dirty with lint which had accumulated. The risk was a cotton mill. The arc, though almost instantly cut off, was sufficient to set the cord on fire, and several inches of it were burned. The fire was quickly extinguished by an attendant, so that practically no damage was done. A few days before this accident another cord developed a short circuit under practically the same conditions. In both cases the cords were hanging free in the air and had not been touched for a number of hours. It is the custom at this mill to frequently turn on and off the lamps by the key sockets and also to frequently brush the lint off the cords. During the summer season the cords are wrapped together and tied in a bunch near the ceiling to get them out of the way. The best explanation of the trouble is that a strand of the fine wire broke and pushed its sharp end through the insulation, causing the short circuit. Both cords had one or two layers of cotton thread first, then a fairly thick outer covering of silk, but they were not rubber covered. These occurrences show, says our contemporary, that however quickly currents may be cut off by fuses, the heat generated by the arc is sufficient to set fire to flexible cords, especially if they are at all greasy and covered with lint. A better cord may not mean one having a higher insulation, but rather one which could not be set on fire. It seems important that cord should be used which would prevent short circuits occurring under as great a number of conditions as possible, and at the same time prevent the flash produced by a short circuit from doing harm.

MISCELLANEOUS NOTES.

German manufacturers of agricultural machines and implements are rather anxious about the severe competition of American manufacturers upon the Russian market. It is stated that a syndicate of American manufacturers is offering to deliver such machines and implements at prices from 30 per cent. to 60 per cent. below the German quotations.—Uhland's Wochenschrift.

Paris is making a sanitary record of every building in the city. Since the beginning, in March, 1894, 35,000 houses have been described, and it is expected that the register will be completed by 1900. It contains for each house a description of the drains, cesspools and wells, and of the plumbing; a record of whatever deaths from contagious disease have occurred in it, and of all disinfections and analyses of water, air, or dust.

The number of passengers carried on the German railways increased more than 99 per cent. from 1885 to 1895. Sixty-one per cent. of the passengers travel third class, 27 per cent. fourth class, 10 per cent. second class, and about 4 per cent. first class. The balance is made up by the army, for which special tickets are issued. A significant fact is that only the number of fourth class passengers has increased 6 per cent., while in the first, second, and third classes there has been a decrease of ½ per cent., 2 per cent., and 3 per cent. respectively. —Uhland's Wochenschrift.

According to the patents, the only combination found suitable for impregnating the mantle used in the Welsbach lamp is a mixture of 99 per cent. thorium oxide and 1 per cent. of cerium oxide. The mantle consists of a loosely woven hose of cotton thread, which is impregnated with a 30 per cent. solution of the nitrates of these rare earths in proportion of 99 to 1. This is then dried and ashed in a specially constructed burner, whereby the conical form is imparted. The thorium nitrate is obtained from the Brazilian monazite sand. When thorium alone is used, only a pale red to violet reflection is obtained. If these earths, however, are used in the proportion of 99 to 1, then an intensely bright white light results. An increase of cerium renders the color more yellow.—Tech. Jour.

Germany's exports of iron, steel and hardware for 1896 amounted to 1,518,626 tons, as compared with 1,527,852 tons in 1895. The total exports of machinery, etc., amounted to 181,227 tons in 1896, as compared with 158,788 tons in 1895, and the total official value of these exports was $119,000,000, as against $114,500,000 in the previous year. Belgium's output of Bessemer and open hearth steel ingots amounted to 598,755 tons in 1896, a gain of 144,136 tons over the previous year, and the output of finished steel amounted to 498,756 tons against 367,947 in 1895. The total output of pig iron in Belgium in 1896 was 932,780 tons, a gain of 103,546 tons on 1895. Of this total 501,195 tons were Bessemer and basic, 364,640 tons forge, and 66,945 tons foundry iron. Under the special tariff law between Germany and Russia, negotiated some years ago, Germany's export business has largely increased. In 1896 Germany's export of iron and steel to Russia amounted to 207,540 tons, exclusive of 34,940 tons of machinery. The gross value of these two items was over $11,000,000, and it practically represents an export formerly coming from England.

An interesting incident is related in the Railway Review in connection with the building of some gunboats, which serves to illustrate the character of Mr. C. P. Huntington, who is the principal owner of the shipyards at Newport News. It was during the panic of 1893, when general business depression was felt throughout the country, that these vessels were contracted for. The shipyard had practically closed down because there was no work, and hundreds of men were out of employment, with families suffering for the necessities of life. Mr. Huntington instructed the superintendent of the industry to bid for the construction of the three gunboats—Wilmington, Helena and Nashville—which Congress provided should be added to the navy. "Make your estimate," said Mr. Huntington to the superintendent, "and then make the bid $50,000 less than the actual cost of construction." When asked why he did it, the magnate replied: "I did that much for humanity's sake. Those men had to have employment, and I could afford to lose $50,000." The contract was awarded to Mr. Huntington's company, the bid being $300,000 under the lowest of the others offered. It was a magnanimous act, and in a few weeks a thousand or more men were given employment, and many hearts were made glad. It is now thought that the company will not lose anything on the vessels, and the premiums they are expected to earn will about cover the deficit, but Mr. Huntington did not know this when he contracted to do the work.

The Engineering News says: "There is food for reflection for officials in towns where a high death rate from typhoid fever has led to a demand for a purer water supply, in some figures which the Jersey City (N. J.) Evening Journal has obtained, showing the reduction in the death rate from typhoid fever that has accompanied the substitution, as the city supply, of pure water from the Highlands of New Jersey for the polluted water of the Passaic River. In January, 1896, the city's water supply was a mixture composed of 28 per cent. pure water and 72 per cent. Passaic River water, and the deaths from typhoid fever numbered 28. In February the percentage of pure water was 40 per cent. and the number of deaths 30, showing that the percentage of pure water in January had been too small to have any effect. In March, April and May the percentage of pure water was increased respectively to 43, 58 and 50 per cent., and the number of deaths fell to 16, 9 and 6. In the five months from June to October, inclusive, the percentage of pure water averaged about 80 per cent. and the number of deaths 4 per month. During the next four months pure water alone was used and the number of deaths averaged only 3 per month. It is estimated on the basis of these figures that the introduction of a pure water supply has saved 75 deaths from typhoid fever in Jersey City in the last eight months, and, in considering this statement, it is to be remembered that similar experiences have followed the substitution of highland or filtered water supplies for polluted ones in at least a dozen or more cities in Europe and in the United States."

[Continued from Supplement, No. 1112, page 17772.]

THE EVOLUTION OF THE AMERICAN LOCOMOTIVE.

By Herbert T. Walker.

In the year 1831 a curious design of locomotive was introduced by Messrs. Davis & Gartner, of York, Pa. It was run on the Baltimore and Ohio Railroad. The boiler and cylinders were upright, with four coupled wheels, 30 in. in diameter, but it was altered considerably after being placed on the road. The Atlantic was afterward built by the same firm, and was a much improved engine. Its boiler and cylinders were also vertical, beams being used to transmit power to the cranks, which were on a shaft connected by toothed wheels to an intermediate shaft having outside cranks coupled to the driving wheels. In consequence of the peculiar shape and movement of the beams, the engines were called "Grasshoppers." Fig. 6 shows one of this class manufactured by Gillingham & Winans for the Baltimore and Ohio Railroad in the year 1835. Wheels 36 in. in diameter; boiler 52 in. in diameter, containing 400 tubes 1 in. in diameter and 3 ft. 2 in. long. Diameter of cylinders 10 in. by 24 in. stroke. Weight of engine and tender, 7 tons 5 cwt. empty. The circular structure at the base of the small chimney is a fan which was driven by the exhaust steam before it escaped.

This fan was for urging the fire. It was, however, subsequently removed and the exhaust steam turned into the large chimney in the usual way. This engine and seven other similar ones were in constant service on the Baltimore and Ohio Railroad for a period of over fifty years. Some of them are now in the Field Museum.

Fig. 7 shows the celebrated John Bull, which is now in the National Museum, Washington, D. C. It was the first engine for the Camden and Amboy Railroad, now a part of the Pennsylvania Railroad. It was designed and built by Stephenson & Company, of Newcastle upon Tyne. This engine represents another step in locomotive construction, for while it somewhat resembles the De Witt Clinton, the cylinders are placed at the smoke box end of the engine, and the smoke box is of the same pattern as used to-day; both these improvements were embodied in the before mentioned Planet engine designed by Stephenson early in the year 1830.

This engine (John Bull) was ordered by Robert L. Stevens, President of the Camden and Amboy Railroad, from Messrs. Stephenson & Company, in December, 1830, and was shipped to Bordentown, N. J., where it arrived in August, 1831. The cut (Fig. 7) was made from a drawing now in the Washington Museum, and is said to be an exact representation of the engine when it arrived in this country; but in a copy of one of Stephenson's working drawings in the author's possession the engine is shown with a chimney of different shape and with a different arrangement of safety valves. This matter is small in itself, but illustrates one of the many difficulties that confront a writer who undertakes to show and describe locomotives built so many years ago.

The engine was originally named Stevens, but on its arrival in this country the railroad company called it John Bull, and it was entered in their books as "No. 1." It was put in service November 12, 1831, at Bordentown, N. J., where the Railroad Monument now stands. The leading dimensions were as follows: Weight about 10 tons; boiler, 3 ft. 6 in. diameter; cylinders, 9 in. diameter by 20 in. stroke. Four coupled wheels 4 ft. 6 in. diameter, with cast iron hubs and locust wood spokes and felloes. Tires of wrought iron $\frac{3}{4}$ in. thick; sixty-two tubes, 7 ft. 6 in. long by 2 in. diameter. Furnace 3 ft. 7 in. long by 3 ft. 2 in. high (for burning wood). Heating surface of tubes, 213 sq. ft.; of firebox, 36 sq. ft. Total heating surface, 249 sq. ft. The firebox was of the dome or Bury pattern. The reversing gear was complicated, the two eccentrics being secured to a sleeve or barrel, which fitted loosely on the crank shaft. A treadle was used to change the position of this loose eccentric sleeve, moving it to the right or left lengthwise on the shaft. Two carriers were secured firmly to the shaft (one on each side of the eccentrics); one carrier worked the engine ahead, the other back, so that when the eccentrics were half way between the two carriers, the axle turned without moving them, and the engine was out of gear. In order to reverse, the engine driver placed his foot on the treadle (which is between the firebox and the handle of the feed water cock), thereby disengaging the eccentrics from the carriers; he then pulled a small handle on the right side of the boiler and so lifted the small ends of the eccentric rods (which passed forward to the rocking shaft on the front of the engine) clear of the valve stems, after which he took hold of the two valve levers on the foot plate, and by moving them back and forth admitted steam to the cylinders by the hand gear; when the engine was fairly started, he, by means of the treadle, caused the eccentrics to engage with the opposite carrier, and it continued to actuate the valves.

Soon after the engine arrived, the Camden and Amboy mechanics made the following changes and additions: As the railroad curves were very sharp, the coupling rods and cranks were removed and a lateral play of $1\frac{1}{8}$ in. given to the leading axle, to which a cowcatcher was connected. The wooden wheels were replaced by cast iron wheels. The dome was moved forward to the former man hole and the boiler lagged with wood. A bell was placed on the boiler and a headlight on the smoke box. A new tender was subsequently built, having a small cab on the rear for the accommodation of a brakeman, who, if anything went wrong with the cars, could signal the engine driver to stop. The engine then presented the appearance shown in Fig. 8. From a cut in the Railroad Gazette of March 9, 1877, it appears that a cab and a large wood-burning chimney were subsequently added, but both these were removed some time before the engine was placed in the United States National Museum.

As far as the writer can discover, this was the first engine equipped with a bell, headlight and cowcatcher, although bells were used on English locomotives as far back as 1827.

This remarkable locomotive was exhibited at the Philadelphia Exposition of 1876, and again at the Chicago Exposition of Railway Appliances in 1883, and lastly, at the Columbian Exposition of 1893. Leaving New York City under steam April 17, 1893, it hauled "the John Bull train" of two cars 912 miles, without assistance, to Chicago, arriving April 22, and meeting with a continued ovation over the entire route. It formed part of the Pennsylvania Railroad Company's exhibit, and was one of the great attractions of the

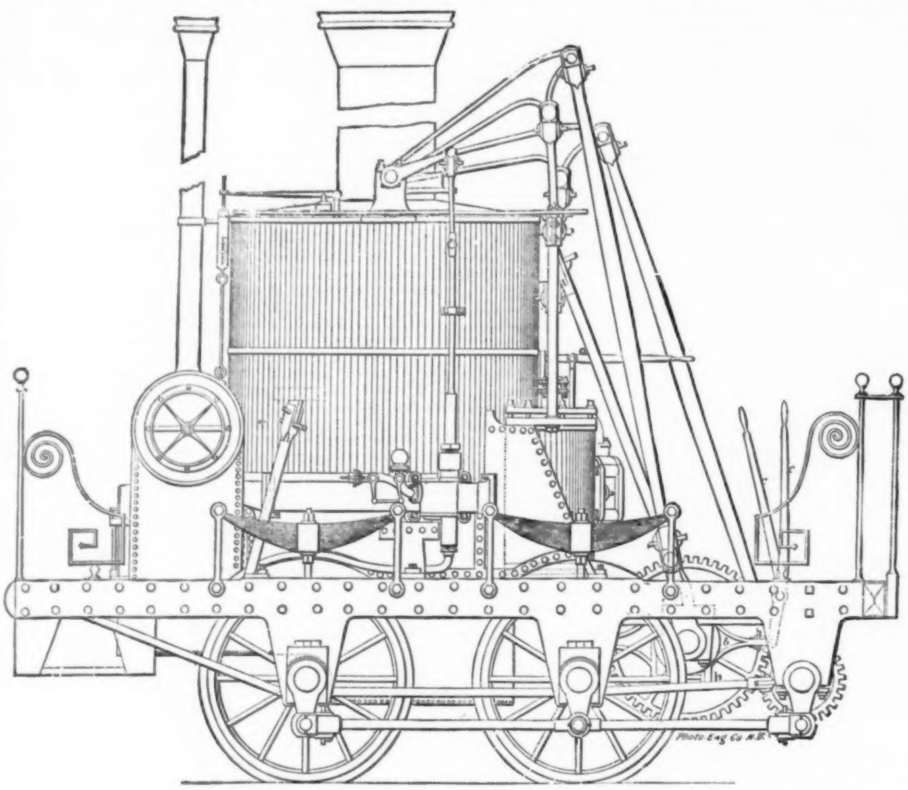


Fig. 6.—GILLINGHAM & WINANS' ENGINE, GRASSHOPPER TYPE, 1835—BALTIMORE AND OHIO RAILROAD.

World's Fair, carrying over fifty thousand passengers over the exhibition tracks in the terminal station yard. The engine left Chicago again under steam December 5, 1893, coming east over the Pennsylvania lines via the Southwest system to Pittsburg, and through Altoona, Harrisburg and Baltimore to Washington, arriving there December 13, 1893. This was a very good performance for a locomotive sixty-two years of age. It was then returned to the museum at Washington, where it will remain permanently.

In the year 1832, William T. James, of New York, invented a very important improvement in locomotive valve gear, viz., the link motion. This reversing and expansion gear is the embodiment of "the beauty of simplicity," for, while the valve gears up to that time and for years afterward were largely made up of a complication of rods and levers, as in the John Bull, they only served to reverse the engine and did not admit of the steam being worked with a varying degree of cut-off and expansion, so essential to the economical working of a locomotive. James' design was nothing more nor less than connecting the small ends

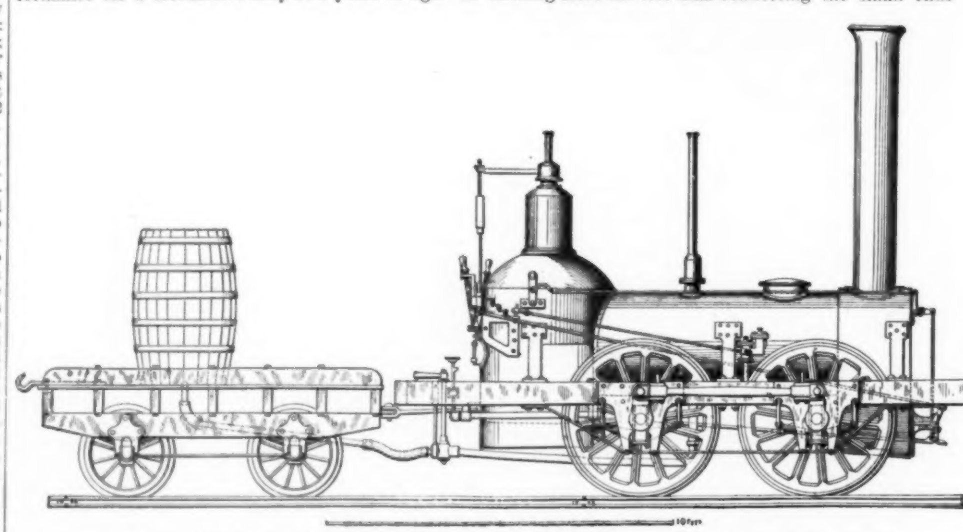


Fig. 7.—STEPHENSON'S JOHN BULL, 1831—FIRST ENGINE FOR THE CAMDEN AND AMBOY RAILROAD.

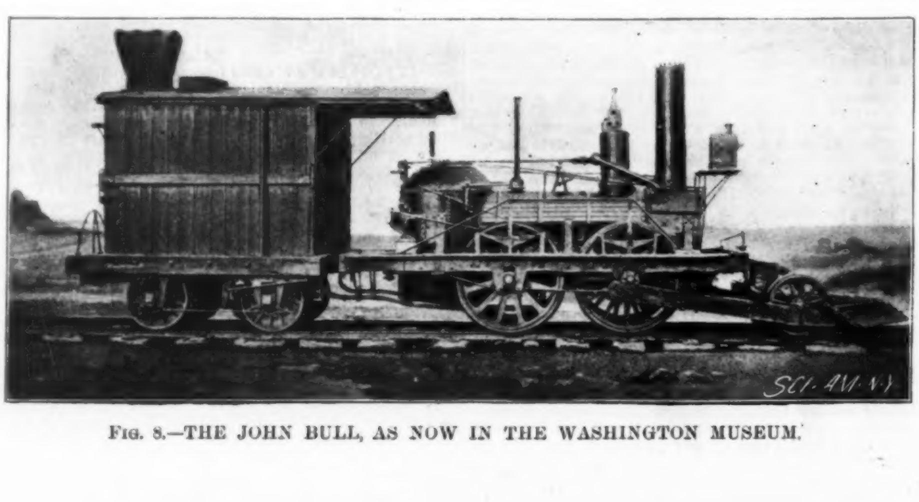


Fig. 8.—THE JOHN BULL, AS NOW IN THE WASHINGTON MUSEUM.

of the fore and back gear eccentric rods by a curved link, the curve being concave toward the eccentrics, said link having a slot which engaged a slide block, fastened to the valve stem. By a hand lever the engine driver could move the link up or down, thus causing either the fore or back gear eccentric to communicate motion to the slide valve and so control the direction of the engine's motion.

The effect of this device as a cut-off mechanism is that when the slide block is in the center of the link, midway between the two eccentric rods, the engine will be in midgear, but on the link being moved so as to bring one of the eccentric rods—say the fore gear rod—opposite to the block, and steam being admitted, the engine will move forward and the valve will cut off the steam when the piston is nearly at the end of its stroke; if the link is moved so that the block will occupy a position between the eccentric rod and the center of the link, the slide valve will cut the steam off at an earlier period of the piston's stroke and so leave the rest of the stroke to be performed by the expansion of the steam, and the more nearly the center of the link is brought to the slide block the shorter becomes the travel of the valve and the earlier will the steam be cut off. Thus, the rate of cut-off and degree of expansion, either for fore or back gear, can be regulated while the engine is running and according to the work it has to do.

This is one of the simplest inventions in the world. There is no valve gear equal to it, and it is used on nearly every locomotive to-day.

James' engine of 1832 (see Fig. 9), fitted with the link motion, was intended for the Baltimore and Ohio Railroad. The boiler was vertical and of weak construction. The cylinders were 8 in. in diameter by 12 in. stroke and the slide valves had ⅛ in. lap at each end. The gross weight was 3½ tons. There were four wheels (not coupled) 3 ft. in diameter.

A representative of the American Railroad Journal visited Mr. James' shop at 40 Eldridge Street, New York City, to examine his wonderful locomotive which had just been completed. He states that the engine was run on a track fifty feet in length, backward and forward eight times in 63 seconds, including stops. Although he does not describe the valve motion, it is evident that none but the most efficient reversing gear, such as the link motion is, would have secured such a result. He also states that Mr. James (a few days later) placed the engine on wheels without flanges and ran it over the pavements and Third Avenue to York-

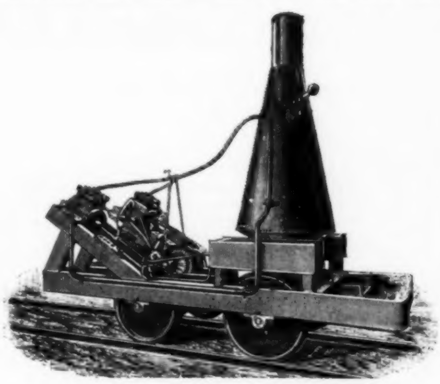


FIG. 9.—THE JAMES, 1832—FIRST ENGINE WITH LINK MOTION.

ville, about five miles, where he took breakfast and then returned to the city.*

It may be mentioned that a weight, which can be seen in Fig. 9, was fixed on the reversing lever to retain the links in position for fore or back gear, there being no means of fixing them in an intermediate position; but Mr. Samuel B. Dougherty (subsequently locomotive superintendent of the Camden and Amboy Railroad), who assisted in the construction of this engine, and wrote a description of it in May, 1858, said that "in setting the eccentrics we found the link would cut off, and we so used it on the engine to expand from different points."†

Before this engine was sent to Baltimore it was run for some time on the Harlem Railroad, where it worked satisfactorily. In 1833 it was forwarded to its destination, but, soon after having been placed in regular service, the boiler exploded and the engine was totally destroyed. A full size model of this engine was sent to the Columbian Exposition.

Strange to say, the link motion after this appears to have dropped out of sight, American engineers using a variety of fork or hook motions, all more or less objectionable, until ten years later, when we will again take the matter up in its chronological order.

In the year 1832, Matthew W. Baldwin, founder of the famous Baldwin Locomotive Works, received an order for a locomotive from the Philadelphia, Germantown and Norristown Railroad Company, whose short line of six miles was operated by horse power. He, in company with his friend, Mr. Peale, went to Bordentown to examine one of Stephenson's engines (probably the John Bull) on the Camden and Amboy Railroad, and made some memoranda of its principal dimensions. After many difficulties had been surmounted, he built a locomotive and christened it Old Ironsides. It was tried on the road November 23, 1832, and is shown in Fig. 10.

A full size model of this engine is now in the Field Columbian Museum, Chicago. Its chief dimensions were as follows: Driving wheels, 4 ft. 6 in. diameter; leading wheels, 3 ft. 9 in. diameter; cylinders, 9½ in. in diameter by 18 in. stroke. They were attached horizontally to the outside of the smoke box, just inside the frames, which were of wood, with iron pedestals. The wheels were made with heavy cast iron hubs, wooden spokes and rims, and wrought iron tires. The boiler was 30 in. in diameter and contained 72 copper tubes 1⅝ in. diameter and 7 ft. long. The reversing gear consisted of a single eccentric, with a double latch eccentric rod gearing alternately on pins on the upper and lower ends of the arms of a rocking shaft. It will be seen that the Ironsides closely resembled the John Bull, except that the leading wheels were smaller than

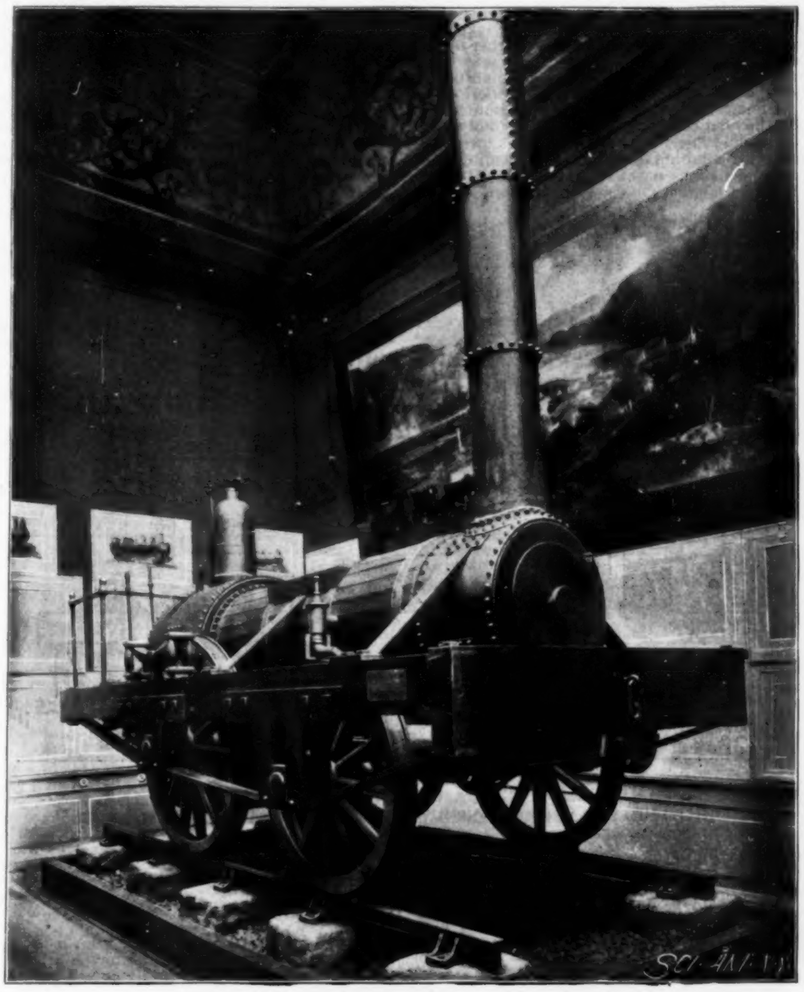


FIG. 10.—BALDWIN'S FIRST ENGINE, OLD IRONSIDES, 1832—PHILADELPHIA, GERMANTOWN, AND NORRISTOWN RAILROAD.

the driving wheels, and the firebox was of the regular Stephenson type instead of the dome or Bury pattern.

This engine weighed about 8 tons and was able to draw 30 tons on a level. It was the first locomotive Mr. Baldwin ever built, and did duty on the Germantown and other roads for over a score of years, and was seen by Zerah Colburn at the Fitchburg Railroad station, Boston, in 1853. It is but justice to Baldwin to add that he soon abandoned the English design of the Ironsides and quickly placed himself at the front in American locomotive practice, some of the finest engines in their day having been built by him.

American designs very soon began to depart from their British prototypes, and a process of adaptation to the existing conditions of the railroads in this country followed.

Until recently, a marked feature of difference between American and English locomotives has been the use of the swiveling truck under the former to facilitate the passage of the engine around curves. An English patent dated December 30, 1812, was granted to William and Edward Chapman for a four wheeled swiveling truck. In the year 1815, Messrs. Blackett & Hedley constructed a locomotive named Puffing Billy for the Wylam Colliery Railway, having two four wheeled trucks, but the truck did not come into general use in England until about thirty years ago.

In the year 1831 Mr. Horatio Allen designed an engine with two trucks for the South Carolina Railroad, of which he was then the chief engineer, but to Mr. John B. Jervis, chief engineer of the Mohawk and Hudson Railroad, belongs the honor of designing the

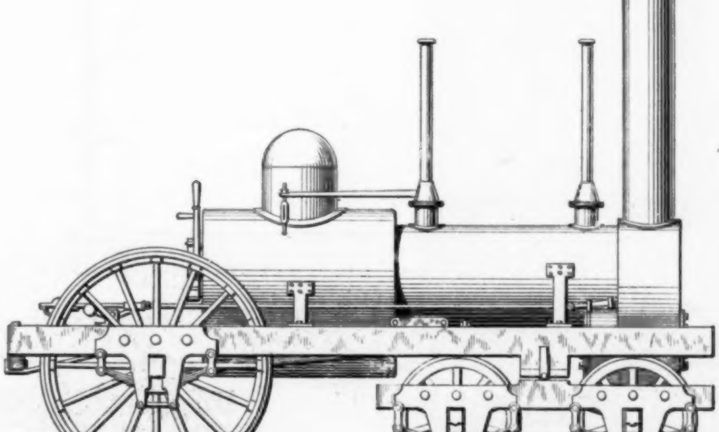


FIG. 11.—JERVIS' EXPERIMENT, MOHAWK AND HUDSON RAILROAD, 1832—FIRST ENGINE WITH A LEADING TRUCK.

* American Railroad Journal, October 20, 1832.

† Colburn's Locomotive Engineering and Mechanism of Railways, 1871.

first engine with a leading truck swiveling on a center pin, as generally used the world over to-day. This was in the year 1831; and in 1832 his engine Experiment was put on the above named road for regular service. The cylinders were 9½ in. in diameter by 16 in. stroke. Diameter of driving wheels, 5 ft. Grate 5 ft. long, for burning anthracite coal. Weight 7½ tons. This important locomotive is shown in Fig. 11. It was the ordinary uncoupled or single driving wheel engine as commonly used at that period, and, as it presents no novel features aside from the truck, further description is unnecessary.*

As time went on, it was found that one pair of driving wheels did not furnish sufficient adhesion and power for the ever increasing loads to be hauled, and, therefore, the next step was to utilize the four coupled wheels embodied in some of the engines previously illustrated and combine them with the leading truck. This arrangement was patented in 1836 by Henry R. Campbell, chief engineer of the Germantown Railroad, "in order to distribute the weight of the engine upon the rails more completely." In the same year he designed the freight engine shown in Fig. 12 (the previous engines were used for both freight and passenger trains), and thus we have the first American eight wheeled engine. It had cylinders 14 in. diameter by 16 in. stroke. Driving wheels 4 ft. 6 in. diameter, the forward pair being without flanges. Gross weight about 12 tons, the adhesive weight being 8 tons. Heating surface about 725 sq. ft. It was tried on the Philadelphia and Germantown Railroad, May 8, 1837, but was found to be a "hard rider," for the reason that it had no means of equalizing the weight on the driving wheels so as to meet the various undulations in the track, and it would also appear from the drawing that the truck had no center pivot, the frame being made with vertical projections sliding in pedestals on the main frame, and being connected thereto by side springs. If this was the case, the truck could only vibrate in a vertical plane and could not turn horizontally. To remedy the defects of the Campbell engine, Messrs. Garret & Eastwick, of Philadelphia, completed in 1837 a new style of freight locomotive for the Beaver Meadow (now the Lehigh Valley) Railroad Company. This engine, named Hercules, had a separate rectangular frame for the four coupled wheels, this frame being pivoted on each side to the main frame by springs and journal boxes sliding vertically in pedestals on the main frame. Thus the separate frame was enabled to move up and down as well as to swing vertically on its center, and so permit the four driving wheels to accommodate themselves to the unevenness of the track, provided the undulations were alike on both rails, which, of course, never happened, and the "separate frame" got badly racked in consequence.

To overcome this objection, Mr. Joseph Harrison, Jr., of the firm of Eastwick & Harrison, patented in 1838 an improvement for equalizing the weight on the wheels of locomotive engines. The preferred form consisted in placing the driving axle bearings in pedestals on the main frame in the usual manner (the separate frame being discarded), and, instead of connecting the driving wheel axle boxes directly to the frame by springs (as in Campbell's engine), a horizontal beam or lever was introduced, having a central pivot linked to a spring fastened to the frame, and its ends provided with rods that passed down through the frame and abutted on said axle boxes. There were two of these levers, one on each side of the engine. They vibrated separately and thus met all the unevenness in both rails. In all equalized engines now built in this country or in Europe this device of Mr. Harrison's is used in one or other of the different ways indicated in his patent.*

These compensating levers are known as equalizers, because, when running on an uneven track, they distribute the shock or jar equally over all the wheels so connected.

Fig. 13 is a side elevation of this important engine as rearranged with Harrison's equalizing levers, and a full size model of it is now in the Field Museum, Chicago. The engine had 12 in. cylinders by 18 in. stroke, and four coupled driving wheels 3 ft. 8 in. diameter. Its gross weight was about 14 tons, of which 9 tons were available for adhesion. With steam of 90 lb. pressure per square inch (then a common pressure in this country) the engine drew a load of 265 tons, including the tender, up a grade varying from 27 ft. to 35 ft. per mile. The speed was not given, but the other particulars are derived from the report of a committee of the Franklin Institute, dated May 9, 1839.

While there is no doubt that Harrison was the original inventor of equalizing levers as used at the present day, it is necessary to call attention to the fact that Timothy Hackworth (Stephenson's great rival) rebuilt a six coupled engine, named Royal George, for the Stockton and Darlington Railway, in the year 1827; each of the middle and back wheels were equalized by a spring in the same way as shown in Fig. 2 of Harrison's specification above referred to. A drawing of the Royal George will be found in Colburn's Locomotive Engineering and Mechanism of Railways, page 21.

Before dismissing the Hercules, we will notice the reversing gear, which was patented by Mr. A. M. Eastwick, July 21, 1835, and is very simple and ingenious. It will be seen by Fig. 13 that the valve chest had two valve stems projecting therefrom. The upper one was for the ordinary slide valve and was connected to a rocking shaft actuated by a single eccentric on the rear axle. The lower one was connected to a movable block working between the slide valve and the cylinder ports. This movable block had four ports, two for fore gear and two for back gear. The fore gear ports (called direct ports) opened directly into the cylinder in the usual way, but the back gear ports (called indirect ports) went but half way through the block, and then turned and passed each other before entering the cylinder. When it was desired to run the engine backward, the block was moved by the hand lever on the foot plate to bring the indirect ports in communication with the cylinder, so that when the slide valve admitted steam to the front port in the block it was conducted to the back end of the cylinder and vice versa. A similar device was patented in England by William Beckett Johnson in the year 1847.

It is interesting to note that Mr. Harrison, in conjunction with Mr. Winans, afterward constructed and worked the rolling stock of the St. Petersburg and Moscow Railway in Russia, and all the engines, nearly 200 in number, originally made at Alexandrowski, near St. Petersburg, were fitted with Eastwick's reversing valve block, and, with the addition of a separate expansion valve, these engines were running as late as the year 1871.

(To be continued.)

* An interesting letter from Mr. Jervis, with an illustration of his Experiment, appeared in the Railroad Gazette, Vols. III and IV.

* The Locomotive Engine, by Joseph Harrison, Jr.

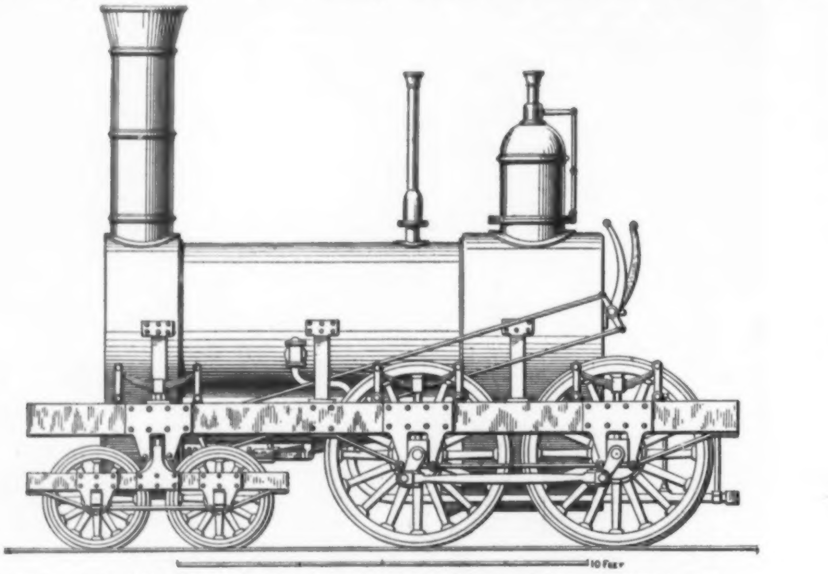


FIG. 12.—CAMPBELL'S FIRST AMERICAN EIGHT WHEEL ENGINE, 1836—PHILADELPHIA, GERMANTOWN, AND NORRISTOWN RAILROAD.

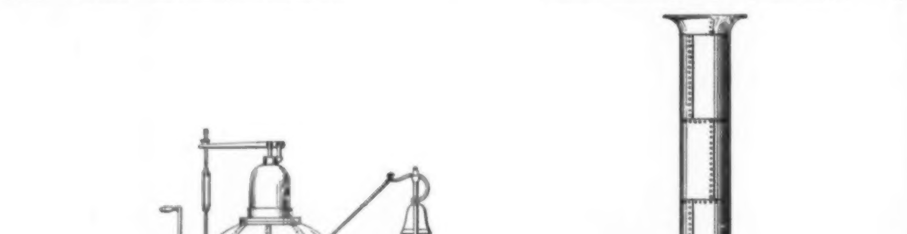


FIG. 13.—EASTWICK & HARRISON'S HERCULES, 1837-38, FOR THE BEAVER MEADOW RAILROAD—FIRST ENGINE WITH EQUALIZING LEVERS.

MINING AND MINERS.

At the general meeting of the Federated Institution of Mining Engineers, the presidential address, delivered by Mr. G. A. Mitchell, reviewed the improvements and changes which had taken place in mining, especially during the last fifty years.

Mr. Mitchell observed that many circumstances had had an influence in bringing about these changes, and among them largely the following: Government legislation accompanied with the appointment of inspectors of mines, the spread of education and knowledge among those engaged in mining, and the establishment of mining societies with the facilities afforded thereby for the publication of information and for the discussion of matters affecting mining in its different branches.

There was nothing more important about a colliery than the ventilation of the workings, and yet forty years ago this was scarcely realized. The inspectors, in the early days of their appointment, had to encounter a good deal of opposition, and there was a large amount of discussion as to the best methods to employ. As far back as 1556, Agricola, in his book "De Re Metallica," gave descriptions of several forms of fans and mechanical ventilators, many of them crude in form, but differing little in principle from the various forms of fans, etc., of the present day.

About the end of the eighteenth and beginning of the nineteenth century several patents were taken out, but the first ventilator introduced to any great extent was that of Struve, for which a patent was taken out in 1846. From that period to 1854 there were many more inventions, some of them of an extraordinary character. For instance, one inventor proposed that steam pipes should be made to circulate round the workings, with here and there "trumpet-mouthed openings for the collection of the noxious air by means of the current of steam."

To the improvements in ventilation, in conjunction with the improvement in safety lamps, was largely due the decrease in fatal accidents from explosions. The death rate per 1,000 persons due to explosions of firedamp was 1·280 in 1851 to 1855, and 0·281 in 1891 to 1894. The speaker looked forward to the time when such disasters would be unknown.

To the improvement in ventilation was traceable a great improvement in the health of the miners. The census returns of 1851 showed that the average number of years during which agricultural laborers of Great Britain continued to work was forty-two and of colliers twenty-eight. This had been changed, and mining, instead of being, as it was then, one of the most unhealthy of occupations, was now one of the most healthy. As a matter of fact, the air in coal mines was better than it was in many factories.

In the various details of the conveyance of coal from the working face to the surface there had been great progress since the middle of the century. It was difficult to believe that as late as 1843 the bearer system was still in existence in the east of Scotland in connection with the edge sea workings, but such was the case. It was in this year that female labor in mines was abolished. There had been a gradual evolution in the winding arrangement for shafts, and the improvements had been largely called forth by the necessity for greater facilities to cope with the increasing outputs. An invention of great importance in this respect was the wire rope, and yet the miners at first resented the innovation. Improvements in screening and picking arrangements and of washing machinery were of a comparatively recent date.

The difference between the systems of underground workings now and fifty years ago was not so great as might be anticipated, and Mr. Mitchell believed there was still room for considerable improvement. Coal cutting by machinery had not yet achieved much success in England, but in America it had made great headway. In the State of Illinois last year, out of a total output of 17,735,000 tons, 3,531,000 tons were produced by 322 machines. If they could get lighter machines, especially if driven by electricity, the use of coal cutters might become general here, with beneficial results.

This reminded the speaker that ludicrous mistakes had been made in the past as to the supposed approaching exhaustion of the coal fields. As far back as 1555 there was an alarm that the coal in Scotland would be quickly exhausted, and an act was passed in 1563 restraining the export, and the same provision was repeated in subsequent years on more than one occasion. In 1609, the reason given for confirming a

former act was "the haill coill within this kingdome sall in a verie schorte tyme be waisted and consumed."

The trouble at the present moment, both for Scotland and England and Wales, was that too much coal was being produced, and that there was a depression in the coal trade in consequence. It was unfortunate that the present time should be chosen for an agitation for a minimum wage.

Colliers scarcely realized how vastly the conditions of labor had improved. It was difficult to realize that less than 100 years ago miners in Scotland were practically slaves. No collier was permitted to remove from one place to another without special permission from his employer, and no person was allowed to engage a collier without a certificate from his previous employer showing a reasonable cause for the change. If the collier deserted, his employer could claim him within a year and a day, and he had to be given back at once under pain of a penalty of £100. The deserters were liable to be punished as thieves.

In conclusion, the president referred to the question of railway rates, and said it was very probable that in the near future motor cars would compete with railways for short distance traffic.

A NEW SECTIONAL GUN.

SOME years ago Pierre S. Licoudis, Lieutenant-Colonel du Génie (Armée Hellénique), published a memoir, "Sur un nouveau système de Bouches à Feu démontables," in which he described, if we remember aright, several sectional guns, which, instead of dividing by a transverse joint, as screw guns usually do, was made in concentric longitudinal pieces. That is to say, the barrel was kept its full length, but the jacket and one or two other pieces were separate from it. This system of division has undoubtedly the advantage that the troublesome circumferential joint is obviated, and the powder gases have as clear a run as in an ordinary piece. The memoir, containing plates and descriptions of this form of gun, was received with a certain amount of favor by Lieutenant-Colonel Lycoudis' fellow officers, and in consequence of that encouragement, and in reply to certain observations, he has now published a second memoir, showing further developments of the proposed system. From the new brochure we reproduce the drawings of "la seule nouvelle création parmi les anciens tracés."

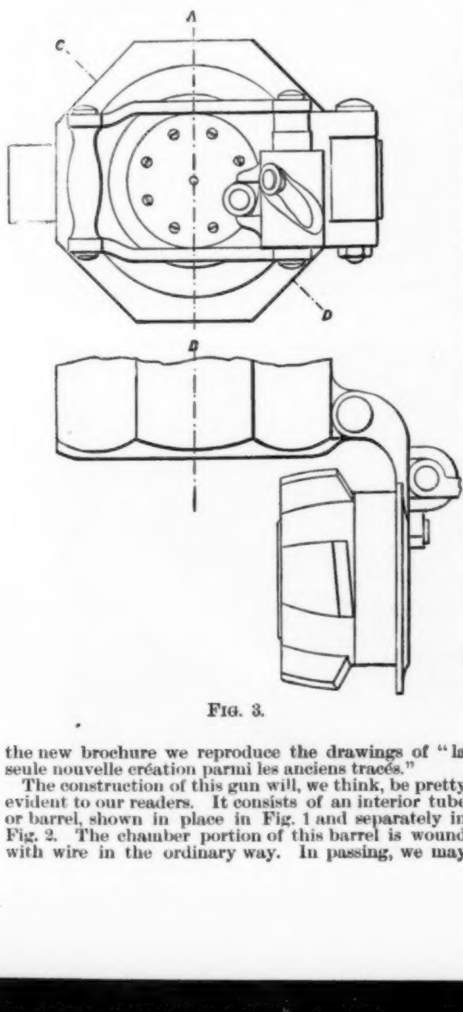


FIG. 3.

The construction of this gun will, we think, be pretty evident to our readers. It consists of an interior tube or barrel, shown in place in Fig. 1 and separately in Fig. 2. The chamber portion of this barrel is wound with wire in the ordinary way. In passing, we may observe that, without entering into calculations, the exterior diameter of this part seems disproportionately small, as apparently it gains no transverse support whatever from the jacket. Compare this section, for example, with the section of the English twelve-pounder wire gun given in the plates in the Treatise on Service Ordnance. On the outside of this barrel there are, as seen in Fig. 2, near the center, and at the breech, four projecting lugs slightly tapered toward the muzzle. These lugs fit into spaces cut to suit them in the two enlargements inside the jacket, and thus prevent any rotation of the barrel from the shot passing along the rifling. The jacket carries, of course, the trunnions, and also a key, which prevents the barrel dropping back through the jacket when the gun is used at great angles of elevation.

Within the spaces referred to at the breech end are four flat springs, which keep the barrel centered within the jacket. The jacket is placed in position by merely dropping it down over the muzzle, no rotation being required.

The final portions of the gun are the breech block, seen in place in Fig. 1, and the mechanism shown in Fig. 3. The breech block, it will be observed, not only closes the gun, but secures the barrel to the jacket by closing the egress to the rear. It is of rather peculiar construction, but will be readily understood from Fig. 3. As will be seen, the tightening is gained by four inclined faces, not by a screw thread proper. These four faces are inclined in two directions, the second, or radial inclination, being necessary to bring the block and barrel tubes central with the jacket. The necessity for it is to be regretted, as it is obviously injurious, as causing a wedge action which would tend to break off the rear portion of the breech when the piece is fired. This is a difficulty which has been appreciated with ordinary breech screws, and to obviate it buttress threads have been occasionally employed, particularly in older cannon. But the breech is nearly always strongly reinforced. This, we note, Lieutenant-Colonel Lycoudis has not forgotten. The breech mechanism is exceedingly simple. A pin in the rear face of the breech block, Fig. 3, fits into a slot formed by two projecting lugs on a sleeve which is caused to move vertically up or down by the motion of a pin on a spindle working in a helical slot in the sleeve. The spindle is rotated by the hand lever. The partial turn given to the block by the first movement of the lever brings the projections on it in front of corresponding openings in the jacket, and further motion of the hand lever withdraws it. The closing takes place in the reverse manner. Nothing much simpler could be imagined, but it offers several defective points to the criticism of an experienced gunmaker. In the first place, a powerful safety catch is an absolute necessity, as the force of the explosion would almost certainly cause the breech block to rotate and open itself. The nominal "angle of repose" for metals seems of no account at all when the sudden tremendous blow of an explosion has to be withstood. We have heard of a case of a screw of such small inclination that the mention of it would seem an exaggeration, rotating under such circumstances. The designer here does not show such a safety gear, and does not appear to grasp the absolute necessity for it, as he only says it may be fitted. Another point which should be considered is, whether the leverage is sufficiently powerful to close thoroughly time after time so large a breech opening, or to unlock it, when the copper obturating ring, seen in Fig. 1, is well closed up after firing, and the block jammed hard back on its shoulders.

This gun is designed to be carried by two mules, the first taking the barrel only, weight about 220 lb., and the second carrying the jacket and breech mechanism complete, making altogether a load of about 230 lb., the total weight of the piece being 450 lb. It is a 3 in. or 12-pounder gun, 20 calibers long, and, ballistically considered, is, therefore, very powerful for its weight. But has not the weight been reduced at a sacrifice of sufficient strength? There are, we think, unquestionably, certain valuable points about this gun. The idea of its construction is good, but the working out is in many ways defective. Whether it would be possible to make a really practical gun on these same lines we are not prepared to say, but we think it should be, and in that case we should have a piece in which many objections to the screw gun would be obviated. We are indebted to The Engineer, of London, for the cuts and particulars.

Fig. 1

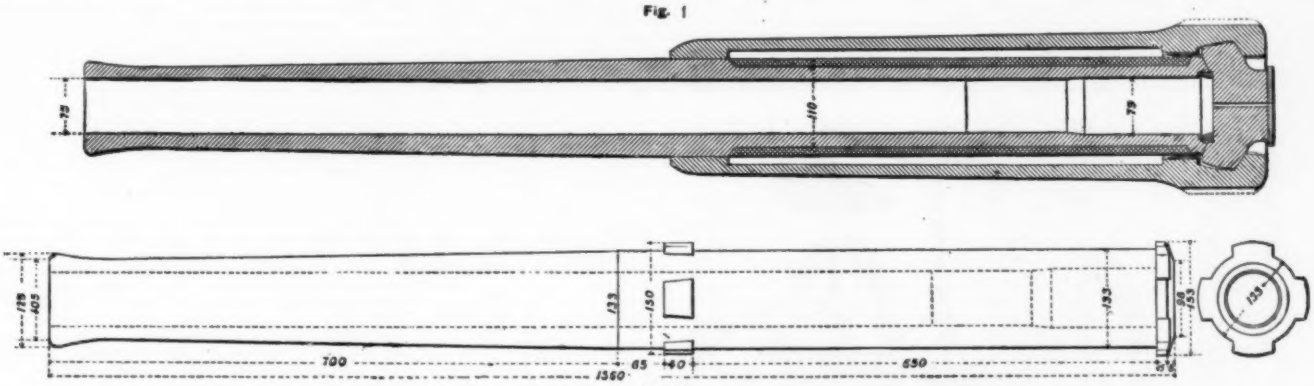


Fig. 2

A NEW SECTIONAL GUN.

The aggregate amount of German exports to Austria-Hungary, Switzerland, Russia and Belgium increased about $50,000,000, or more than 25 per cent., from 1892 to 1895. The exports to the United States in the same time increased $5,500,000, or over 7 per cent. Exports to France remained about the same, but there was a considerable depression in 1894. 1895 was a very good year for the German export trade. In manufactured goods alone the exports increased $75,000,000 over 1894.—Uhland's Wochenschrift.

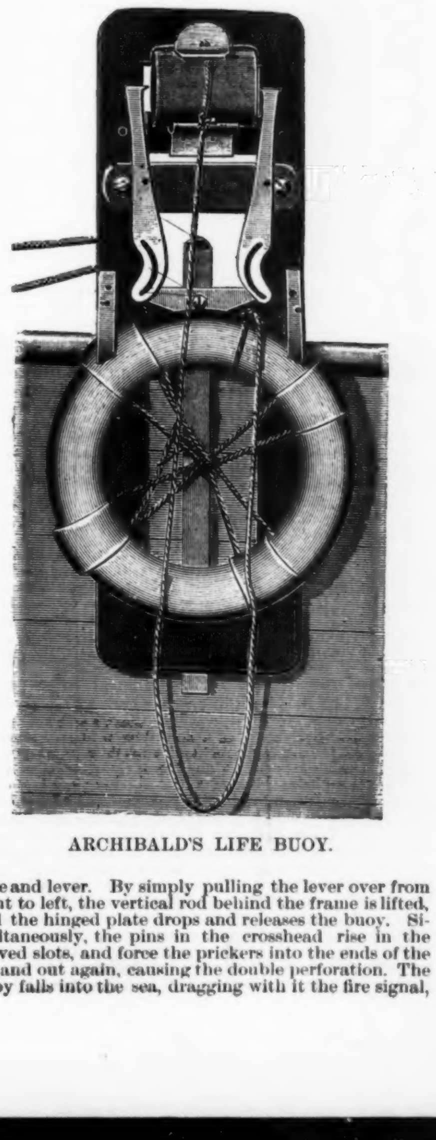
A NEW LIFE-SAVING APPARATUS.

THE life buoy detacher and automatic fire signal lighter, which we illustrate below is the invention of Capt. Archibald, of the Empress of India. The advantages possessed by it over existing systems of life-saving apparatus are that the ordinary circular life buoy and the regulation fire signal, which according to the Board of Trade rules must be carried on all seagoing ships, can be utilized in conjunction with it.

It is well to point out that the regulation fire signal consists of a small cylindrical tin, made fast to the life buoy, containing chemicals which are capable of producing a flare light for the space of about half an hour. To set it in operation, both ends of the tin must be perforated, and it must be thrown into the water, by which combustion of the chemicals is caused.

Capt. Archibald's apparatus consists of a light hard wood frame, which supports both signal and buoy, already attached to each other. The buoy is maintained in position by two fixed clamps above it, and by a third hinged clamp below. The signal is similarly held by one fixed clamp above, and one below, which, while not being hinged, will readily yield and liberate the signal when the weight of the falling buoy is brought to bear.

Behind the frame is a long rod capable of movement vertically, and having fixed near its lower end a hinged plate which supports the buoy. Close to the upper end of the rod is fixed a crosshead, at the extremities of which are pins. Each of these, when the apparatus is in position, rests at the bottom of a quadrant slot at the lower end of a pricker arm or lever, one lever being attached to the right and the other to the left of the upper portion of the frame. The prickers are on the tops of these levers, and point opposite the center of each end of the tin signal. This frame can be placed in any convenient position at the sides of a ship, and is controlled from the bridge or elsewhere by a double rope and lever. By simply pulling the lever over from right to left, the vertical rod behind the frame is lifted, and the hinged plate drops and releases the buoy. Simultaneously, the pins in the crosshead rise in the curved slots, and force the prickers into the ends of the tin and out again, causing the double perforation. The buoy falls into the sea, dragging with it the fire signal,


ARCHIBALD'S LIFE BUOY.

which instantly ignites on touching the water. The whole operation can be done in less time than is usually employed in detaching the buoy and throwing it into the sea without the fire signal. This is of great value where a few seconds of time saved may mean the difference between life and death.—Engineer.

LOYAL'S GASOLINE MOTOR.

The list of gasoline motors applied to automobile locomotion is already a lengthy one, and it is not in order to increase it a particle that we now present the Loyal motor, of which, up to the present, there have been given only brief descriptions that are little in keeping with the interest that it possesses from various points of view.

This motor, which we believe was first exhibited to the public at the fourth Salon du Cycle, is differentiated from all others by its extreme simplicity and by a method of operating which is absolutely new in a great number of points. It belongs to the two period class of motors, that is to say, it gives one effective piston stroke per revolution, while at the same time presenting the characteristic phases of four period motors. The eduction valve, like the admission one, is entirely

EXPERIMENTAL TRICYCLE DRIVEN BY THE LOYAL GASOLINE MOTOR.

automatic. It acts without either cam or eccentric under the effect, simply, of the pressures and depressions caused by the motion of the piston. This reduces the apparatus to its essential and indispensable pieces, to wit: a cylinder, an ignition tube, an admission valve, an eduction valve, a piston, a connecting rod and a cranked shaft; that is all.

The admission valve, which is connected with the carbureter and arranged at the bottom of the cylinder, opens from without inwardly, while the eduction valve, placed upon the cylinder near the center of the stroke of the piston, opens from within outwardly. These valves are held upon their respective seats by springs whose tension regulates their automatic play, as we shall show in describing what takes place at each entire revolution of the driving shaft.

Let us suppose, in order to make things plain, that the piston is at the end of its stroke at the bottom of the cylinder, and that it has compressed a certain quantity of the explosive mixture that has previously been drawn into the carbureter.

The compression of the mixture produces its ignition through the intermedium of a small nickel tube heated to a dark red and arranged toward the bottom of the cylinder. The explosion thrusts the piston until it has passed beyond the eduction valve. At this moment the latter opens and a partial expulsion of the burned gases takes place. As the piston continues its motion, the pressure in the cylinder diminishes up to the moment when it becomes inadequate to prevent the eduction valve from closing. The piston, continuing its stroke, creates a vacuum in the interior of the cylinder. The admission valve opens and permits of the entrance of a little carbureted air, which takes its place in the bottom of the cylinder and remains there by reason of the difficulty experienced by the diffusion of the new gas in the burned gas. The piston having reached the end of its stroke, the cylinder contains, at the pressure of the atmosphere, new gas at the bottom and burned gas toward its open extremity. In its back stroke the piston compresses this mixture, and, at a given moment, the eduction valve opens automatically a second time in order to permit of the escape of that portion of the burned gas that occupies the bottom of the cylinder. Such escape occurs up to the moment at which the piston passes beyond the eduction valve. Starting from this instant, the gases that remain in the cylinder are compressed as far as to the end of the stroke. At this moment, the ignition through the nickel tube takes place, and the same phenomenon is repeated indefinitely.

Upon the whole, during the course of the increase of the volume of the cylinder limited by its bottom and that of the piston, there has successively occurred an explosion, a partial escape of the burned gases, a suction and an introduction of new gases, and, during the retrograde stroke corresponding to the diminution in volume of the cylinder, there has occurred a compression and second partial escape of the burned gases, while the valves have acted without any special controlling arrangement. This constitutes the principal feature of originality and simplicity of M. Loyal's motor. Another interesting feature is the method of ignition. The nickel tube, once heated externally, and raised to the desired temperature, maintains of itself the temperature required for the ignition of the explosive mixture without the aid of any external heat, thus permitting of extinguishing the lighting burner after the motor is set in operation. The ignition takes place even after the motor has been stopped for a few minutes, without its being necessary to heat the nickel tube anew.

The carbureter also merits a special mention. It consists of two superposed reservoirs, the upper of which contains the gasoline and communicates with the lower through a small valve. This lower reservoir communicates with the admission valve and with a tube that opens in the atmosphere. The suction produced by the admission valve creates a vacuum in the lower reservoir that causes air to enter it and sets in motion a fan wheel that stirs up the air while the valve, in opening, allows a little gas to flow into the reservoir and upon the fans of the wheel. The motion of these assures an intimate mixture of the gasoline and air, while the richness of the mixture is regulated by a spring that presses against the valve of the gasoline reservoir and a cock that limits the entrance of the air into the carbureter. It is unnecessary to say that this carbureter is not indispensable to the operation of the motor, which may be supplied by any sort of apparatus of the kind.

We have had no opportunity to determine the consumption of this motor. M. Loyal says that it is from 5 to 6 ounces of gasoline per horse hour. This figure is very small as compared with those furnished by analogous motors of equal power (3 horse), and we give it with every reserve; but the fact that the 3 horse power motor used in a small polishing shop of the inventor operates without cooling water and by the simple cooling action of the fan wheel seems to indicate a good thermic utilization, unless the high temperature of the waste gases causes them to carry into the atmosphere the greater part of the heat not transformed into work.

The illustration shows the first application of the motor to an experimental tricycle that was exhibited at the fourth Salon du Cycle.—La Locomotion Automobile.

THE CYCLODROME.

In 1896, at Evian, at the Exposition of Geneva and in the cycle cottages at the Bois de Boulogne, at Paris, an apparatus was seen that attracted the attention of cyclists of both sexes. It was a sort of indoor velodrome for training purposes, invented by Mr. Guignard, of Lausanne.

The realistic home trainer permits the cyclist to pedal and revolve his wheel in a room just as if he were upon the road. The apparatus consists of three horizontal rollers mounted in a frame and almost entirely covered by a platform. These rollers are connected with each other and so arranged that, when a cyclist takes his place upon the platform with a bicycle, the steering wheel passes over one of them and the driving wheel over the two others. As soon as the pedaling is begun, the driving wheel carries along the rollers, and, as the latter whirl around under the machine by reason of the velocity given them, the cyclist is ever working without succeeding in leaving the flying road. It is as if he were speeding over an endless road that moved along with him. It is possible in this way to make, in situ, as many miles and obtain such speed as may be desired. The cyclist is always running with the rollers without advancing an inch.

The rotary motion of the rollers is transmitted to an indicator consisting of a dial and hand upon which is read the speed attained and the number of miles made. It is also possible, by means of a brake, to increase the resistance and place the cyclist in the same conditions in which he would find himself if he were climbing a more or less steep ascent. In 1896, at Geneva and the Bois de Boulogne, it was left to any one to place his wheel upon the apparatus and show his strength as a cyclist. The rollers hummed in their rapid revolution, and the racers, pedaling in situ with energy, became heated, perspired, and watched the dial with their eyes. They made 18, 20 and 25 miles an hour, and, under encouragement, 35 and 40 miles. That was all, for the cyclists could do no more. Some of them pedaled but three or four minutes before reaching the extreme speed of 40 miles, but the majority did not attain this figure. Fortunate were those who caused the hand of the dial to point to 25 and 30 miles.

This pastime was very popular, and the more so in that professional racers often mixed in with the best trained amateurs. This exercise, which is somewhat too violent, if carried to excess, may, however, be proportioned to the size and strength of each individual and serve not only for training the inexperienced, but also for teaching the secrets of cycling to beginners. It is easy to keep one's equilibrium upon the rollers, to seize hold of a post in case of too great an inclination, and to easily pedal, without fear, upon this new moving road.

At the last Salon du Cycle this apparatus was exhibited on a considerably larger scale. Upon a wide platform there were grouped, parallel with each other, four or five of the roller machines, so as to put several professional racers in line. Each machine, through a simple transmission, imparted motion to the top of a long table on which were placed miniature racers that recalled the small casino horses of seaside bathing places. These little racers, with their machines, ran over this long track by reason of the efforts put forth by the cyclists who were pedaling upon the rollers. Each cyclist wore colors corresponding to those of his miniature protegé, so that his speed was no longer shown by a hand revolving over a dial, but by the movements of the Liliputian racers upon their track. At a pistol shot the rollers immediately began to revolve, the cyclists, beginning slowly, accelerated the strokes of their pedals and the miniature bicycles consequently moved forward upon the track.

Finally the goal was reached, and then what a triumph and what frantic applause! The true racers, as if they themselves had covered 24 miles, disappeared amid acclamations in order to give place to other contestants. The cyclodrome was again in favor last winter. What will it be in the fine season?—La Nature.

PHOTOGRAPHING FLYING BULLETS.

In a recent lecture, says the Army and Navy Journal, Prof. C. Vernon Boys, F.R.S., described his process of photographing flying bullets by the light of the electric spark. In order to get an electric spark at the very time the bullet from the rifle was passing the photographic plate, the bullet in its passage was made to effect an electric junction of two lines of wire, thus causing the spark by the light of which the picture was taken. The lecturer demonstrated that the ordinary notion that an electric spark is instantaneous was quite erroneous, and he stated that the light of the two ends of the ordinary electric spark lasted a little less than the 100,000th part of a second. It was, of course, instantaneous to our senses, but to tests which could measure accurately to the 100,000,000th part of a second the electric spark was anything but instantaneous. This spark was no good for taking the photograph of a flying bullet, as the lecturer showed by exhibiting one of his attempts, which made quite a blurred picture. He then proceeded to explain the steps which he took in order to reduce the length of time of the electric spark. To this end it was essential that the terminals should be made of copper, platinum, or some metal which did not produce readily an ignitible vapor, and the electric current must not be driven through wires at all. He used a very thick, broad band of copper, not more than 2 inches long, which reached round the edge of the plate, so that the electric current had not

THE CYCLODROME.

got more than 3 or 4 inches to go altogether, and it had a very broad copper path by which it could travel. He explained by diagrams how he had effected his object, and shortened the time of the spark to about $\frac{1}{15000000}$ of a second, or about a hundred times quicker than the ordinary flash. To give the audience some idea of this infinitesimal fraction of time, he said the time occupied by the spark as reduced by his apparatus was proportionately as much less than a second as a second was less than five months, and during that time a bullet fired from a magazine rifle could not travel more than $\frac{1}{500}$ part of an inch. By his simple contrivance he was able to get a brighter and shorter spark, and all that was necessary to make a good and sharp picture. Prof. Boys exhibited a series of lantern views, showing various portraits, and, in addition, some which had been produced by two officers of the Italian artillery, who, working upon the same lines as himself, had greatly improved upon his apparatus, and had secured some wonderful effects.

RECENT IMPROVEMENTS IN FLOUR MILLING.

Flour milling has been really an industry only since the application of buhr millstones to the grinding of cereals, for it is only beginning with that epoch that it has been possible to obtain flour adapted for making bread. In fact, dating from that period, hydraulic mills began to be set up along watercourses, and then windmills in certain valleys and especially upon hills.

It was in 1780 that the art of grinding grain was studied for the first time, and that by two Frenchmen—Colonel Ducrest and Engineer Favre. Both had conceived of the transformation of the primitive methods of grinding grain, but their propositions found only slight encouragement in France, and it was to the new world that they went to ask for a recognition of their studies. Oliver Evans, an American engineer, aided them in their work, and, in 1782, the first mill doing low grinding was established in the United States. This was the cause of the development of the cultivation of wheat in that portion of the globe.

The English came afterward (in 1789), and, finally, in 1816, the first French flour mill was mounted at Saint Quentin by Mr. Mandley, an Englishman, whence is due the name of "English grinding" for the ordinary work done by buhr millstones.

Since that epoch there have been three kinds of mills in use:

1. The ordinary mill, run by water.
2. The modern mill, run by steam.
3. The windmill.

The processes of grinding have been modified only in the auxiliary apparatus that make the indispensable complement of it; and it may be said that the first system of grinding remained the same in France up to 1878, the epoch at which the Caro disintegrator made its advent at the Universal Exposition, along with the Gand (Hungary) white cast iron cylinders and the Wegmann (Swiss) porcelain ones.

In the first processes employed the mechanical elements of a flour mill consisted of just what they do to-day, viz., of apparatus for cleansing, grinding properly so called, and bolting.

We shall speak at present of the cleansing. Of all the operations of flour milling, this is the most important and indispensable, and that, too, whatever be the system of grinding adopted—millstones, cylinders, granulators, disintegrators, etc.

In fact, it does not suffice to grind the grain. The operation of grinding, be it as well done as possible, cannot prove irreproachable unless there has first been removed from the grain the least traces of dust and other impurities that adhere to it, and the presence of which would injure the appearance and quality of the flour.

Such a result can be obtained only by means of numerous improvements introduced into the existing apparatus, since, up to recent times, the scouring of grain has consisted solely in the elimination of fine straw, pebbles, long and round seeds, and all other bodies foreign to the grain itself, while the complete extraction of the embryonary envelope and of the germ it self—parts that Mr. Aimé Girard has pointed out as being useless as human food and injurious to panification—has been too much neglected.

Before thinking of improving the grinding properly so called, it was therefore extremely necessary to improve the method of cleansing, and, before reducing the cereals to flour, to be sure that there should enter into it only the substance of the grain, that of which the digestion and assimilation is possible, easy and profitable to man.

Many new apparatus have been constructed for a short time past and appear to us to merit serious attention from the standpoint of the problem to be solved, viz., to submit to grinding only such grain as has been perfectly freed from all foreign substances and of all impurities capable of altering the flour and interfering with panification.

For manufacturers, the problem was not so much to increase the number of apparatus as to construct new ones provided with strong parts (such as fans for aerating the grain, suction devices for removing the dust, hermetical jackets for preventing evaporation, etc.), and to devise a method of treating the grain in such a way as to give, upon grinding, only grits thoroughly freed from impurity. This problem has been solved in great part by a few manufacturers.

The operations of cleansing may be classified as follows:

1. Elimination of foreign materials.
2. Classification of the products.
3. Purification.
4. Removal of germs.

A thorough cleansing as now understood necessitates the following apparatus:

(1) A distributer, which prevents any interruption of the passage of the grain by straws, strings, corks or other objects of some bulk.

(2) A smut and screening machine designed to eliminate earth, pebbles, sand, etc., from the grain.

(3) A winnowing machine that removes substances that are lighter than the grain.

(4) A separator, which, as its name implies, separates foreign seeds of elongated form (such as oats, barley, etc.) or of round form (such as vetches, corn cockle, etc.) from the wheat with which they may chance to be mixed.

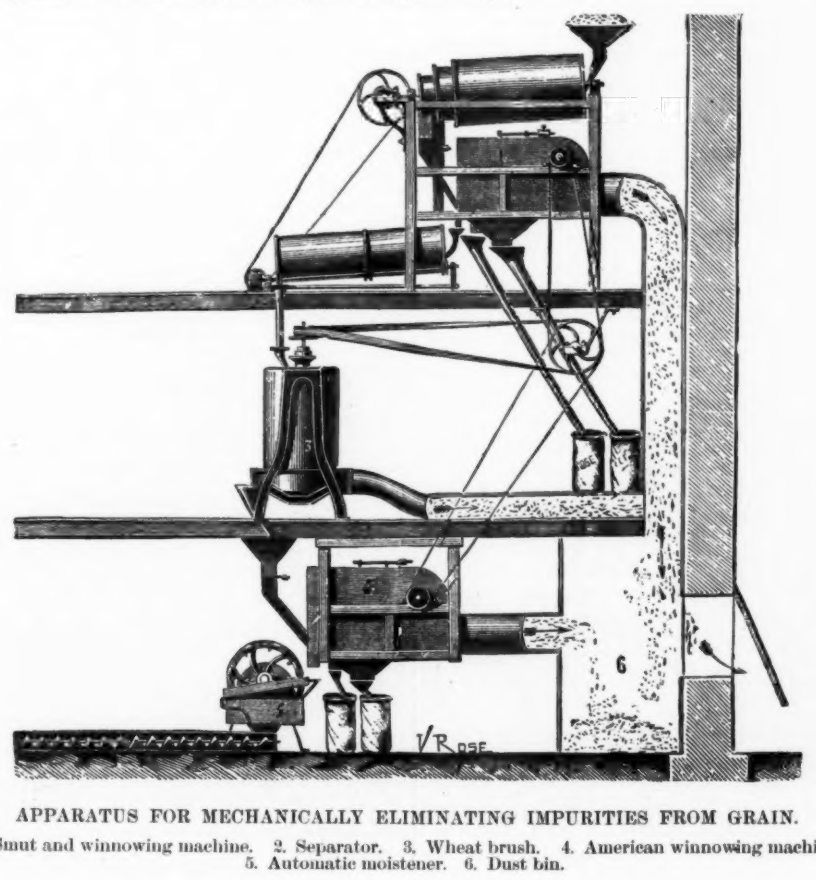
(5) A brush which, through an energetic friction, finishes the scouring of the surface of the grain.

(6) A magnetic apparatus designed to remove tacks, nails, screws, bolts and all particles of iron that might be contained in the wheat or get mixed with it in its passage through the preceding apparatus.

(7) A moistener designed to slightly dampen the grain (especially hard grain) so as to give the bran pellicle sufficient elasticity to prevent it from being reduced to powder in subsequent grindings.

(8) A splitter, or a compressor, for splitting the grain or else slightly flattening it in order to prepare it the better for grinding. These two apparatus are considered as an excellent addition to the cleansing devices.

This nomenclature is not absolute, but varies according to the use of apparatus designed to unite in a single one several of those that we have just enumerated. Nevertheless, we may say that, in all well mounted mills, it is such an organization as this that we meet with and that gives the best results.—La Vie Scientifique.



APPARATUS FOR MECHANICALLY ELIMINATING IMPURITIES FROM GRAIN.

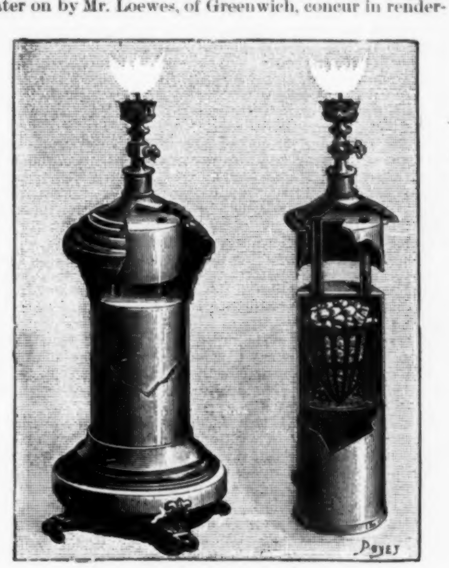
1. Smut and winnowing machine. 2. Separator. 3. Wheat brush. 4. American winnowing machine. 5. Automatic moistener. 6. Dust bin.

LETANG & SERPOLLET'S ACETYLENE LAMP.

The apparent facility with which it is possible to obtain a production of acetylene gas by means of the action of water upon calcium carbide has already led to the devising of a large number of portable gas generators.

These tentatives are all far from having been crowned with entire success, and it is only by making the gasometers of large dimensions that a satisfactory operation of such apparatus has been obtained.

Different causes, which were first pointed out by Messrs. Letang and Serpollet and well demonstrated later on by Mr. Loewes, of Greenwich, concur in rendering the disengagement of the acetylene irregular.



LETANG & SERPOLLET'S ACETYLENE LAMP.

Among these must receive prominent mention the property possessed by the lime (resulting from the decomposition of the crude calcium) of temporarily absorbing a large quantity of water when its temperature is raised, and of setting it at liberty when the mass cools.

The effects of this variable hydrometricalness of the lime have a disturbing influence, so much the more important in that they manifest themselves in apparatus whose operation is regulated by an intermittent discharge of the liquid, as well as in those whose principle is based upon the duration of the immersion of the carbide in the water.

If, in fact, we consider what takes place when a notable quantity of carbide is submitted to the action of water, we shall see that on the one hand acetylene is disengaged and that on the other lime is formed that is immediately hydrated and the temperature of which increases considerably on that account. The effect of such thermic elevation, as direct measurements have shown, is to cause the lime to absorb fully three times its weight of water.

When the contact of the carbide with the water is suppressed for the purpose of arresting the disengagement of the acetylene, the temperature has a tendency to lower, and the lime sets free the water that it has just stored up. The latter reacts upon the carbide in causing a superproduction of gas, which must be collected in a gasometer of large capacity or else be allowed to escape into the air.

In order to remedy this defect, it has occurred to certain American manufacturers to make gas generators with extremely strong sides, and perfectly closed, in which the gas produced in excess accumulates and becomes compressed.

Too numerous accidents caused by acetylene stored up under pressure have demonstrated the undeniable danger that the handling of such apparatus presents.

An arrangement that permits of getting around this difficulty has been devised by Messrs. Letang & Serpollet in an entirely different order of ideas.

Just as the kerosene that we burn in our lamps is not the impure liquid that comes from the wells of Pennsylvania and Baku, and that cannot be so used, just so the carbide of calcium that comes in a crude state from the electric furnace cannot be employed in gas generators of small dimensions.

As the residue of compact lime, the principal obstacle to the regular operation of the apparatus, could not be suppressed by the mechanical means tried in the first place, recourse was had to the use of chemical processes, and it was thus that the problem was definitely solved.

There are but a small number of substances that have the property of dissolving lime, and it was impossible, on another hand, to have recourse for this purpose to mineral acids, such as hydrochloric acid, for example, the corrosive action of which would go so far as to destroy the generators themselves.

Organic chemistry offered a wider selection, and the substance adopted as presenting to the highest degree all the qualities requisite, and, at the same time, absolute innocuousness, was glucose.

This substance has the property of combining with lime in forming a non-caustic and very soluble sucrate, which is not poisonous. It is regularly employed, on account of its cheapness, under the name of corn sugar, in the manufacture of sirups and preserves of inferior quality.

The carbide of calcium, intimately mixed with the glucose by means of a mechanical process that we shall not describe here, becomes converted into a substance having qualities that are so novel that it may, after a manner, be qualified as refined.

It has, in fact, become insensible to humidity, has

lost its characteristic odor and decomposes without leaving any solid residue in contact with the water.

The portable acetylene lamp that the use of the prepared carbide has permitted of realizing is based simply upon the principle of the Gay-Lussac hydrogen lighter.

The apparatus consists (1) of an external reservoir having the form of a cylinder bulging at its upper part; (2) of a receiver surmounted by tubes that lead the gas into a filter, filled with fine filaments of glass and closed at its upper extremity by a cock; and (3) of an openwork basket supported by a rod fixed to the lower part of the receiver by a bayonet catch.

The charging of the lamp is a very simple operation. The basket, previously filled with carbide, is fixed beneath the receiver, and the latter is introduced into the large reservoir. Water is poured into the latter until it is nearly full, and the cock is then opened. The air under the receiver escapes in the first place; then, after an instant of contact with the water, the carbide is attacked, the acetylene is disengaged and all that there is to do is to light the burner.

When the cock is closed, the lamp is extinguished. The water is forced back by the gas, the disengagement of which ceases as soon as the contact with the carbide ceases to exist. The latter, in fact, does not rest upon a bed of lime, but upon the wire forming the basket, which is capable of retaining so small a quantity of water as to be practically negligible.

After all the carbide has been decomposed, it is necessary, in order to recharge the lamp, to renew the supply of carbide and change the water in the reservoir.

The largest type of the lamps of this system now in the market holds eighteen ounces of refined carbide, which permits of a continuous lighting for six hours, with a luminous power of at least twenty-five candles.

The price of the refined carbide is subject to the same variations as that of the crude, but it may be pretty accurately estimated at five cents a pound.

In taking as a basis this figure, which will certainly be reduced ere long, it will be seen that the hourly expense of the lamp is but one cent. In order to obtain a light of the same intensity with kerosene, it would cost one and a half cents, and with the wax candle a little over twelve cents.

For the lighting of our dwellings, acetylene may, therefore, be economically substituted for kerosene, which comes exclusively from foreign countries.

Lime, carbon and sugar are all, the inverse of kerosene, products of our national industry, and the electric energy itself necessary for the formation of carbide of calcium is derived from the hitherto almost inutilized power of our mountain torrents.

Science sometimes possesses means that permit of solving international economic problems that are apparently unassailable.

In this pacific and fecund contest of intelligence against matter we cannot deprive ourselves of the pleasure of asserting that our country remains in the first rank.—A. Etançon, in La Nature.

AN ENGLISH MATCH FACTORY.

By JAMES CASSIDY.

SIR EDWIN ARNOLD, writing upon the "Sixty Years' Reign of Victoria, Queen and Empress," thus records an incident connected with the match industry: "As I returned home"—upon the morning of the proclamation of Her Majesty as Queen Victoria—"asking a hundred questions from my nurse about kings and queens and the new reign, a man in the street was selling, evidently as a singular novelty, lucifer matches at a half penny apiece. He held up the little sticks, one at a time, and then drawing them through a folded piece of sand paper, produced an instantaneous flame, to the intense amazement of the passers-by, and, doubtless, to his own considerable profit. On that morning, as on all mornings before, I had, probably on awakening from sleep, witnessed my nurse kindling the fire, or lighting the dressing candles, with an old fashioned flint and steel, laboriously striking the wayward sparks into the smutty tinder, and then applying to a traveling fringe of fire the point of a splinter of wood dipped into brimstone, bundles of which used to be sold by beggars in the highways. So did we procure the sacred element when this reign began; little, if at all, advanced beyond the firestick of the savage. But, since then, what a cheap and universal possession has that precious element of fire become, which, according to the Greek myth Prometheus stole from the gods as the best of gifts for mankind, at the cost of terrible personal penalties! Among the countless vast advances made by civilization generally and by England in particular, during the Victorian era, how rarely does anybody think of the enormous service rendered everywhere by the simple innovation of the phosphorus match, which I thus saw sold for a halfpenny a sample, on the Queen's coronation day. Ex luce lucellum! There is much profitable reflection to be got out of that early lucifer. The principle of it was, of course, the same as that of the branch which chafes itself into conflagration in the dry forest, or even the firestick of the aboriginal—a production of flame by friction, that is to say, with the substitution of phosphates or chlorates for carbon. But what a difference the little invention has made to mankind? We were far from many vast and marvelous additions to the comforts of human life in those first days of the great reign, but among its smaller, yet most valuable, boons we all actually lived without the unspeakable luxury of the box of matches for a halfpenny."

It was about the year 1827 that the lucifer match was invented, and a short time after this matches were being manufactured in Vienna, Darmstadt, Frankfort, Prague, and the United States.*

The first thing necessary to the manufacture of wooden matches is duly seasoned timber, and it is quite the usual thing to find stacked at one time on the banks of the Lea, for conversion into lucifer matches, £35,000 worth of timber. A large proportion of the wood stacked is white Canadian pine. This is of a very

* One of the earliest manufacturers of matches in this country was William Bryant, of Plymouth. This gentleman was the founder of the firm of Bryant & May, who now own one of the most important match manufactories in this country, turning out annually four hundred millions of boxes—in round figures, nearly thirty thousand millions of matches. In addition to these, about one-seventh of this number of safety matches is produced, and over thirty thousand gross of vesuvians. Then there is the small matter of nine hundred miles of wax vestas per day.

straight grain, and the wood best adapted to the industry. The pine wood is not allowed to stand for long, but is converted into matches while quite fresh, as the sap not being out of it, the pores are open.

In addition to these walls of plank timber, there are others more picturesque, of tree trunks. These are of aspen and poplar, and are mostly used in the manufacture of match boxes.

The first process to which the wood for the manufacture of splints is subjected is that of planing. This cleans the surfaces, which, together with the edges, become soiled during the period of stackment. The surface planing is done by machinery, that of the edges by hand. From the planing machine to another decisive monster brings us to the second process, that of sawing into regulation blocks. There is something of a misnomer in the word "sawing," when applied to the mechanism which, in automaton fashion, flashes a bright steel knife through the wood brought to it, and lo! the plank is cut into sections.

These larger blocks are steamed, and, while still hot and tough, again severed into smaller blocks, and subsequently submitted to an ingenious machine, possessed of a double motion, which cuts the wood lengthwise and crosswise into splints of the requisite thickness for lucifer match making.

Matches, like needles, are made in twos; each splint measuring $4\frac{3}{4}$ inches, before its dual nature is established, by the two heads finally imparted, and the decisive action of the descending knife upon its center. The splints descend into a hopper, from whence they are taken and made up into bundles, an average of 2,000 splints going to the bundle, equal to 4,000 matches. Over 125,000 of these bundles are manipulated in this one match factory during the working week. Up to this stage in the manufacture of matches, men and boys only are employed, and women and girls are conspicuously absent.

The possibilities of the wood stacked in such large quantities upon the wharf as already intimated are not by any means exhausted by match making. The huge logs—whole tree trunks—are dealt with in the same section of the works as are the planks, and are manipulated into boxes, for the reception of the finished matches. Imagine, then, a tree trunk, intact, brought up to a circular saw, placed above it, and, in less time than it takes to tell, the saw whizzed through it. As it ascends the knife rotates at a great speed, and enters the wood transversely. The result, a block, suggestive of a "Christmas log."

The trunk section is brought to the edge of a sharp and rapidly revolving disk, which barks it. The flying bark passes behind a guard into a bin, and the denuded log is conveyed from the barking machine to a machine which, discarding technical terms, we will designate a parer. By this the excrescences are peeled off and rejected, and the evened block is shaved into lengths, in much the same way as an apple or potato is pared. One could very well fancy himself watching operations in some linen rolling mills of the North. The "laying" machine also scores the wood—i. e., slightly marks it for the doubling into shape of the match box case.

The sides of match boxes, which are afterward to receive bottoms and the familiar paper covers, are cut from thin sections of wood at the rate of thousands per minute by means of a very sharp knife. These sides are also slightly incised, for bending into shape. One ingenious machine, by a multiple movement, puts on the paper, inserts the bottom, and closes the paper over it, thus forming the neat box used alike by Nansen in the polar regions and the denizen of the tropics. The match box cases are covered, with equal dexterity, by another hard working machine, at the speed of sixty per minute.

It would seem that "fashion" in labels prevails in this and other lands. Whole districts get to prefer a particular color and design, and will have nothing but that color and design. Those who use the "Lion" avoid the "Royal Hunt," or the "Ruby;" indeed, not far short of a hundred designs are now on the market, placed there by one firm.

The last process in the manufacture, so far as the boxes are concerned, is that of drying. The damp boxes, covered by their cases, are deposited in square sieves, and the sieves are placed upon iron pegs in drying cupboards, or frames. By automatic movement the sieves and their contents are precipitated by a slow sliding from peg to peg, and by the time that they have made the descent two or three times in the heated atmosphere the boxes are dry enough for immediate use or for stacking.* In the manufacture of those boxes destined for the reception of wooden matches, other than safety, the glass paper is pasted on by hand; while in those required for safety matches, the prepared surface upon which the matches are ignited is painted on the boxes, several dozens at a time, with a brush.

The match box industry has a twofold aspect, hundreds of thousands of match boxes being made outside the factory, in the homes of the industrious and decent poor of the East End of London. It has been said that a woman working fourteen hours a day at match box making can only earn six or seven shillings a week, but Mr. Charles Booth, in his able work "Life and Labor in East London," has demonstrated that an average worker earns by a ten hours' day ten shillings a week, and in some cases twelve and sixpence a week. Were it not for the thoughtlessness of the ordinary British consumers who help to send £400,000 per annum out of this country, to the producer of foreign matches, there is no reason why the match box maker of London's East End should not find it possible to double her earnings and halve her work.

But to return to the splints. These, tied up in bundles, are submitted to progressive operations. The first of these is known as "coiling." The splints are placed, large numbers at a time, in a "filling" machine. From the hopper they pass to groves immediately beneath, and from grooves they are mechanically wound beneath leather belts. Each splint preserves its distance from its fellow. The coiling results in an eight thousand axled wooden wheel, of some fifty-four inches in circumference. The two faces of the wheel are "beaten" by the descent of a heavy iron disk, and from the "beater" the coils are made to travel over hot iron plates. This heating process opens the pores of the wood and so prepares it for a paraffin bath. The contents of the bath are held in a double bottomed iron

* In the Fairfield Road Works I looked upon a storage of nine million boxes.

tank, and are kept, by means of steam, at one temperature. In the "good old days" of bad habits the splints were dipped in brimstone, but in these later days paraffin is preferred. It may be asked, "What is the use of a bath?" The answer is easy, to those who know all about it. It gives inflammability to the wood and avoids the necessity for "undue proportion of igniting paste."

The next process is known as "dipping," and its result is the head on the match. The "dip" is a substance of paste-like consistency, variously colored. One of the ingredients of this emulsion is phosphorus. The dip is mixed in a separate apartment known as "The Mixing Shop." From its original receptacle it is "ladled out on to a shallow, flat-topped iron box, which is kept hot by steam admitted into its interior."

This colored paste is distributed over the plate, until an equal and requisite thickness is attained. Then the coils or wooden wheels are "dipped" or pressed with decisive firmness into it. It has already been stated that each splint is cut the length of two matches. Only one end is, however, dipped at one time. This is allowed to dry, and by an ingenious contrivance the coils of wet splints run away automatically, through holes in the flooring, to the drying rooms below; there they are suspended from racks for the purpose of drying, the "tipped" end downward. The rack of splints presents a fantastic appearance, suggesting well filled giant pincushions, and the more particularly as the "dip" is many colored.

And here an observation seems called for, upon the localization of color. Fashion would scarcely be looked for in the color of the heads of matches, yet it prevails. By what strange unwritten law Lancashire, as a whole, should prefer pink, with the solitary exception of Preston, which favors blue, is hard to determine. Then, again, the south of the Emerald Isle would appear to believe in the red-headed match, while the town of Limerick finds satisfaction in a blue lucifer. Coal-mining Northumberland sees a fitness in black, and there is reasonableness in the vision.

But to return to the "giant pincushion" or suggested wheel—the coiled splints. One end thoroughly dry, the reverse end is dipped, and, in its turn, allowed to dry. The drying completed, the uncoiling is accomplished with pleasing dexterity by a well-constructed and ingeniously wrought machine. In the "Needleries" of the Midlands, the "stiffs" or wires are submitted to a process known as "pointing." The "stiffs," pressed against the face of a revolving grindstone, and by a dexterous movement made to revolve individually against it, are ground alike on all sides. The effect is not only a true point, but a brilliant succession of sparks, evoking exclamations of admiration from the visitor who looks upon the scene for the first time.

Standing in one of the long galleries of the spacious boxing room of this huge factory, and looking down from this eminence upon the panorama below, I saw hundreds of busy workers standing before benches upon which were piled heaps of splints that had been separated by machinery from their coils into loose but regular heaps. The speed with which these are taken up in handfuls, with such exactness of calculation that scarcely one out of every hundred handfuls differs a couple of splints from the other, and then placed in the groove of a small machine standing in front of each worker, and dividing which is a large handled knife, is more than surprising to the novice. To borrow the apt phraseology of a brother eye witness, "The operator divides the handful of double ended splints with one swift downward stroke, supplying, by this action, the exact contents of two ordinary match boxes. With one motion the inner cover of the empty box is forced out, with another it receives its quota of contents, another closes the box, and the operation of halving and boxing matches is accomplished." It is in the pyrotechnic results sometimes obtained in the "halving" of the splints that the analogy to the results accompanying the process in needle making, already indicated, suggests itself. "Every now and then the friction caused by the quick passage of the dividing knife through the bundle of splints sets fire to the whole, which is rendered so much 'waste.' The rapidity with which these skilled workpeople operate, the movement and color, the crunching and splintering of the splints, the 'firing' of the ill-fated bundles, and the smoke and flame that issue from them, form, on the whole, one of the prettiest, busiest and strangest sights imaginable. There is something uncanny about this vivacious scene, to which the unavoidable sulphurous fumes arising from the 'fired' matches lend color as well as actuality. The degree of expertness arrived at by these hands is bewildering, for there are many different sizes of boxes, yet the worker hardly ever makes a miscalculation in the proper proportions of her handfuls. A worker in this department can fill from thirty-five to forty gross of boxes during a working day."

From the boxing room to the store room is the next journey for the filled match boxes; here they are carefully built into walls, each brick, so to state it, being a neat bundle of from three to twelve dozen boxes. The last operation to which the boxed matches are submitted is the casing. The manufacture of the cases affords work to very many hands; it is an industry in itself. The cases intended for export are tin lined and iron mounted. Every box of matches prior to packing is wrapped in waterproof paper to minimize the risk of damage, and finally the entire case is overhauled, marked and dispatched by van to the docks, and from thence, if necessary, by lighter to the ship in which the journey is to be made. So much for wooden lucifer matches and their boxes as seen in the making at an English match factory.

The manufacture of the pretty, delicate looking wax match is, from some points of view, even more interesting. It has already been stated that nine hundred miles of wax vestas are turned out from this single factory in one day—a number sufficient to allow of the laying of an unbroken line from Cornwall to the north of Scotland, or to form a double line from London to Glasgow. Yet, large as is the quantity made at Bow, it is almost needless to assert that the entire output of civilization's wax vestas is not by any means from one factory. Indeed, competition is so keen, and the British housewife so unpatriotic, that these nine hundred miles might be multiplied a hundredfold, and yet leave a fair share of the vesta manufacture to other nationalities.

The writer was once on a visit of inspection to a con-

fectionery factory in the northeast of London, where the profit sharing system prevails with advantage to all concerned. One of the firm was addressing the work-people—some two thousand men and women. In the course of his address he requested every man or woman who had ever inquired before purchase whether an article was of British manufacture to hold up the right hand. Two hands only were raised, giving an average of one in a thousand who ever asked such a simple and practical question. Were the same inquiry made of British housewives—and the bulk of the money is spent by them—it is probable that even worse results would be obtained. The principle upon which oftentimes the lady of the purse does her housekeeping is this: she complacently purchases foreign made and foreign marked goods, from Monday morning till Saturday midday, and then, on Saturday afternoon, attends a meeting convened to consider British trade versus foreign competition.

But to return to the vesta factory. The base of the "wax" match, so familiar to smokers, is a hard, white substance practically known as stearine. Nearly 1,000 tons of wax stearine, gum, etc., and over 300 tons of cotton are used here annually in the making of vestas. It has been calculated that it would take one man, working ceaselessly ten hours a day, and striking twenty-four matches a minute, a period of five years and four months to use one day's turn out of the Fairfield Works wax vestas.

Have you ever taken from your neat metal vesta box a wax match, and holding it at each end between thumbs and forefingers, unwound it to expose the threads in order to see how many there really were? If not, you may be surprised to find that there are no fewer than twenty-two such threads in a single match. At either end of the taper making workshop are huge drums, resembling giant bobbins, and between these drums are steam jacketed tanks containing a preparation of stearine. The threads, as they are steam wound from one set of drums to another, are caused to pass through this warm wax bath. In the sides of the tank are inserted steel perforated plates through the holes of which the tapers are drawn. These holes are uniform in size and of the required circumference. Seven times the cotton is bathed, or until it comes up to the gage determined by the holes in the plate.

When sufficiently dry the tapers are cut into lengths, and subsequently to the exact length of vesta match required. A smart mechanical contrivance catches each vesta and holds it in position in a square frame. When 7,300 vestas are in the frame, the whole thing is depressed into the composition. The frames are then run into fireproof drying rooms and the result is the familiar wax vesta.

The condition of the English "factory girl" has received exhaustive treatment at the hands of Miss Clara E. Collet in Charles Booth's "Life and Labor in East London."

It may not be considered out of place here should we quote what she has to say upon the subject:

"Of the industries carried on in the East End in factories only three of any importance numerically are managed entirely in the factories—viz., the cigar, confectionery and match industries. Outdoor hands are employed in all the other trades, although not by all employers in these trades, and this outdoor employment touches closely the question of the irregularity in the employment of indoor hands. On the whole, work in the factories is regular. More single women would be employed if work were not done at home, and domestic competition perhaps prevents wages from being so high as they would otherwise be. But it is obvious that any employer who uses machinery must be anxious to utilize his machinery and rooms to the utmost; and, on the whole, the irregularity in the employment of factory girls is due to the state of the trade and not to any carelessness on the part of the employer, who would always like to give full work throughout the year if he could. . . . In the match factory there is a slack season when either the work must be shared, giving smaller earnings to each, or the inferior hands must be dismissed. During this slack season many of the girls leave of their own accord, and sell flowers and watercresses, pick fruit and go hopping, but this does not fill up the whole time. Which alternative should the employer choose? Should he divide the work among them all, or should he in slack times dismiss hands? This problem, in some form or other, must be faced by employers in every trade. Is half a loaf better than no bread? During a temporary scarcity it is. In the factory the expense of machinery and buildings tends to prevent the employer from taking on more hands than are required in full work, and in slack times it seems best to divide the work among them all. But, unless the girls have saved in their best times, they naturally complain so much at their smaller earnings that it sometimes pays the employer better to dismiss the inferior hands and to give the rest the opportunity of earning their usual amount. And the girls never do save. If their standard of living included saving for slack times, they could force wages up to that point in the season. But so long as they only wish they could save, and always spend all their money, so long will full wages merely correspond to necessary wages, i. e., they will only be enough for present wants."

This writer visited the Victoria factory, at Bryant & May's Fairfield Works, and continues:

"I was much struck by finding that out of the thirty-two who had earned less than nine shillings in the week six had been absent two days, seven had been absent one day, and six had been absent half a day, and that the holiday was nearly always taken on Monday. This irregularity of attendance is found in all factories among what might be called the eight shilling to ten shilling girls. These wages give these girls as much as they care to work for, and after that they like holidays best. They are often the daughters of dock laborers, or other irregular workmen, frequently drunkards. They have been brought up in stifling rooms, with scanty food, in the midst of births and deaths year after year. They have been accustomed to ups and downs; one week they have been on the verge of starvation, another they have shared in a 'blow out.' They have been taught unselfishness by the most skilled of teachers, self-indulgent parents. They have learned to hate monotony, to love drink, to use bad language as their mother tongue, and to be true to a friend in distress. They care nothing for appearances, and have no desire to mix with any but their equals. They are generally one of seventeen, of whom all may be surviving or a dozen dead. . . . On the whole these girls, outside their homes, lead a healthy, active live. They do not over-exert themselves at the factory, following the example of the little girl who was neither very good nor very naughty, but just comfortable. They rise early, and have plenty of outdoor exercise, both on their way to and from the factory, and in their evening walks. They are rough, boisterous, outspoken, warmhearted, honest working girls. . . . Their great enemy is drink; the love of it is the curse they have inherited, which later on, when they are no longer factory girls, but dock laborers' wives, will drag them down to the lowest level, and will be transmitted to the few of their children who survive. They are nearly all destined to be mothers, and they are almost entirely ignorant of any domestic accomplishments. 'Something should be done' is the vague declaration made by would-be social reformers. The something which should be done is, to some extent, being done already, by quiet workers among the East End working girls, who, coming in contact with them in their clubs, their evening classes and social gatherings, and in their homes, know well that improvement in the condition of these girls is identical with improvement in their moral character."

One of these "quiet workers"—all honor to her—is to be found at Clifden Institute, almost immediately opposite Fairfield Works. This is an ideal institute, made use of by some four or five hundred per week of the girls working at Bryant & May's factories, as well as by girls working at other industries in the vicinity. Attached to the busy institute is a restaurant, where over 1,200 meals a week are served. A working woman can obtain from this useful restaurant a good dinner of roast beef or mutton, greens and potatoes or haricot beans, with a subsequent serving of sweet pudding—boiled suet, jam tart, or baked batter—for the modest sum of 3½d.! Or should it be that breakfast is required, a rasher of bacon, a fresh egg, or a nicely toasted fish, with a cup of tea, coffee, or cocoa may be had any morning for 1½d.! For friendless and homeless factory girls the institute has a little lodging house, under the management of a gentle lady; any girl, provided she is respectable, may board and lodge in the home for an inclusive charge of six shillings per week. Educational classes are held in connection with the institute, and these are appreciated by many of the match girls. Needle work is a strong point. We have it upon the authority of the lady who presides over Clifden Home that "numbers of the girls could not hold a needle when they first attended here, but they all showed an eagerness to learn, and have progressed so well that over a thousand garments are turned out during the year." This lady also informed us of the great improvement that had been made in the wardrobes of the workers. Most of them were without under bodices, or night dresses; they never thought of wearing them; now it is the exception to find a girl without these necessary garments, at any rate in the Home Lodging House. Several of the members are hard at work upon their own trousseaux. Formerly a scarlet and purple jacket and a half dozen showy feathers would have been deemed a sufficient outfit with which to enter upon the matrimonial state!

During the sewing hours the behavior of the girls is surprisingly good. They work hard, are teachable, and never give expression to a wrong word. All are devoted to their teacher, and vie with each other in doing her such little services as they can.

As an instance of the good effected by the influence emanating from the institute, it may be as well to record an incident made known to me by a friend some years ago. A young lady, the daughter of a clergyman in the parish, happened to be walking down Fairfield Road, just as the match girls were trooping out from their day's work. These rough daughters of labor soon espied their lady sister, and without more ado a number surrounded her, took off her bonnet and cloak, tried them on themselves, one after another, and finally replaced them the wrong way about upon the unfortunate young lady. Then, with volleys of bad words and shouts of derisive laughter, they bade her "begone." Indeed, such was the character and behavior of the workers, that respectable people were afraid to incur the chance of meeting them in numbers after dusk.

Now, thanks to the good work of the institute, the idea of behavior of this kind would be scouted by every woman and girl in the factories, and their conduct in the streets is exemplary, and has already attracted the notice of a bevy of ladies and gentlemen in the neighborhood.

A scheme has been put in motion by the Clifden Home authorities to induce the operatives to save regularly a certain portion of their earnings, and it is working fairly well. Recognizing the fact that the match girls would not go to the savings bank, the savings bank has been brought to them, and the result is many a penny laid by for a rainy day. The "pooling" of money is discouraged, and wisely, as it has an element of gambling in it, and is contrary to thrift. The "pooling" is carried on in this way: some score of girls lay down, say, a shilling each, and then draw lots for the results. Nor is the money thus doubtfully acquired wisely spent on useful clothes, but is generally outlaid in the purchase of an astonishing hat, feathers, ornaments for the hair, rings for the fingers, or gaudy outside attire. The match girls have always shown a remarkable power of combination. To them belongs the largest union of women and girls in England.

In conclusion, we would point out that the reduced use of phosphorus, the enforcement of strict rules regarding cleanliness and carefulness, the excellent system of ventilation, the regular inspection of factories, and above all the earnest spirit that prevails at Fairfield Works, and at other great centers of industry among employers, have done much to eradicate the evils incident to match making, and to raise the social status of thousands of hard working women and girls.

It rests with the British housewife to secure to her native land the benefits accruing from the manufacture at home of lucifer matches, whether of wax or of wood.—Gentleman's Magazine.

MUNICH is to derive 6,000 horse power for various purposes by electricity, from the river Isar.

PASTE AND GLUE.

IN the Photographic Times Mr. W. H. Gardner collects a number of formulæ of various mountants, of which we give the following:

GELATINE MOUNTANT (NO. 1).

Cooking gelatine	1 ounce.
Alcohol, 95 per cent	10 "
Glycerine	½ to 1 "

Soak gelatine in cold water for an hour or more, take out and drain off all the water which will go, add to alcohol in wide mouthed bottle. Add one-half to one ounce of glycerine, according as gelatine is of a hard or soft kind. Put bottle in hot water, with occasional shaking until gelatine is quite dissolved. Will keep indefinitely, and has only to be heated when wanted for use.

ANOTHER (NO. 2).

Nelson's No. 1 photographic gelatine	4 ounces.
Water	16 "
Glycerine	1 "
Alcohol	5 "

Dissolve the gelatine in the water, then add the glycerine, and lastly the alcohol.

PERMANENT PASTE (NO. 3).

Arrowroot	10 parts.
Water	100 "
Gelatine	1 "
Alcohol	10 "

Soak gelatine in the water, add the arrowroot which has first been thoroughly mixed with a small quantity of the water, and boil four or five minutes. After cooling add the alcohol and a few drops of carbolic acid.

ANOTHER (NO. 4).

Best Bermuda arrowroot	1¾ ounces.
Sheet gelatine or best Russian glue	80 grains.
Water	15 ounces.
Methylated spirit	1 "

Put the arrowroot into a small pan, add one ounce of water, and mix it thoroughly up with a spoon, or the ordinary mounting brush, until it is like thick cream, then add fourteen ounces of water and the gelatine broken into small fragments. Boil for four or five minutes, set it aside until partially cold, then add the methylated spirit and six drops of pure carbolic acid. Be very particular to add the spirit in a gentle stream, stirring rapidly all the time. Keep it in a corked stock bottle, and take out as much as may be required for the time, and work it up nicely with the brush.

STARCH PASTE (NO. 5).

Pour cold water on good laundry starch to barely moisten it. Then stir in boiling water until proper consistency is reached. Squeeze through canvas if not free from lumps. Starch paste should be freshly made for each batch of prints.

ANOTHER (NO. 6).

Allow four parts by weight of hard gelatine to soften in fifteen parts of water for several hours, and then moderately heat until the solution is quite clear, when 65 parts of boiling water should be added while stirring. Stir in another vessel 30 parts of starch paste with 20 of cold water, so that a thin milky fluid is obtained without lumps. Into this the boiling gelatine solution should be poured while constantly stirring, and the whole kept at a boiling temperature. When cool, add to the whole ten drops of carbolic acid to prevent souring. This makes a very tenacious paste.

CASEIN MUCILAGE (NO. 7).

Heat milk with a little tartaric acid, whereby casein is separated. Treat the latter while still moist with a solution of six parts of borax to one hundred of water, and warm gently while stirring, which will cause the casein to be dissolved. Of the borax solution enough should be used to leave only a little undissolved casein behind.

GOOD MOUNTING PASTE (NO. 8).

Add to 250 c. cm. of concentrated gum solution (2 parts gum to 5 parts water) a solution one gramme sulphate alumina in 20 c. cm. water. (Alum does not answer the purpose as well.) The addition of the sulpate is effective, in that this gum is not so readily softened by moisture, and, besides, wood can be fastened to wood by means of it. Its adhesive qualities are in general greater than those of pure gum arabic.

IMPERVIOUS PASTE (NO. 9).

Soak ordinary glue in water until it softens, remove it before it has lost its original shape, and dissolve in ordinary linseed oil on a gentle fire until it acquires the consistency of a jelly. This paste may now be used for all kinds of substances, as, besides strength and hardness, it possesses also the advantage of resisting the action of water.

THIN MUCILAGE (NO. 10).

A paste that will not draw engravings when pasted down on paper must be thin. A mixture of equal parts of gum tragacanth and gum arabic forms with water a thinner mucilage than either one alone.

LIQUID GLUE (NO. 11).

With any desired quantity of glue use ordinary whisky instead of water. Break the glue in small fragments and introduce these into a suitable glass vessel, and pour the whisky over them. Cork tightly, and set aside for three or four days, when it will be ready for use. The whisky must not be too strong, and a little heat is generally required.

ANOTHER (NO. 12).

Same as above, except that acetic acid is used in place of whisky and that the bottle containing ingredients must be placed in hot water to dissolve the glue.

ANOTHER (NO. 13).

Glue	8 ounces
Water	8 "
Nitric acid	2½ "

Dissolve the glue in the water by immersing vessel

containing same in hot water. When solution is effected, add the acid. Effervescence will take place with the evolution of orange nitrous fumes. Now cool. It should be kept in a well stoppered bottle, and will remain permanently liquid.

As regards the formulæ collected by Mr. Gardner, we may remark, says the Photographic Review, that of the above, Nos. 13, 12 and 9 are quite unfit for mounting silver prints, although they may be useful for other work in the studio; Nos. 12 and 13 for cardboard and light woodwork, where the presence of acid is not likely to be detrimental; and No. 9 (which is really an emulsion of glue and linseed oil, and requires well beating together) for cementing articles likely to be exposed to damp. Strips of cloth used to make the developing room light-tight may well be cemented with No. 9, especially if ten grains of finely powdered bichromate of potash be stirred into each ounce just before use.

The desirability of employing Nos. 7 and 8 as mountants for silver prints is open to doubt, although these are excellent for cementing all such ordinary materials as come under the denomination of "stationery."

We thus have left adhesives Nos. 1, 2, 3, 4, 5, 6, and 10 as quite safe for silver prints if good materials are used, and do not become decomposed subsequently. Gelatinous mountants made with a considerable proportion of alcohol, like No. 1 or No. 11, have the advantage of not considerably stretching either mount or print, and are especially useful when prints (whether silver or Woodburytype) have to be mounted on thin card as book illustrations. In the case of Nos. 2, 3, 4, the alcohol is used mainly as an antiseptic, and is not present in sufficient quantity to have much influence as a preventive of stretching or cockling. The simple starch paste, No. 5, is not satisfactory in all instances, owing to want of sufficient adhesion, in which case it is an excellent plan to adopt No. 6, in which starch and gelatine are used together.

DANGER TO SUBMARINE CABLES IN CASE OF WAR.

THE following paragraph is taken from the Electrical Review, of London, but it sounds a note of warning that should be of value in the United States. We read in the Pembroke Dock Gazette that H. M. S. Seahorse, the special service vessel, has recently had an interesting and valuable experience in relation to submarine telegraph cables. The Seahorse has on board the Hon. Capt. Vereker, of the Admiralty Hydrographer's Department, on a special cruise around the coast taking sketches of capes and headlands. Recently, while between Land's End and the Wolf Light, a kedge anchor was dropped to moor the vessel for sketching purposes. In weighing the kedge, a submarine cable, to which it had become attached, was raised to the surface. Twenty miles further north another cable was taken up. It appears that the officers of the ship were of opinion that the cables communicated with the Scilly Islands and Ireland respectively. We read that this experience, unique in its character, was the subject of much conversation on board. We have no doubt that the above mentioned incidents must have aroused serious speculation in the minds of the naval gentlemen on board concerning the ease with which telegraph cables could be interrupted. It was pointed out in the House of Lords in 1885 that as long ago as 1878, when there were great alarms as to a Russian war, "the Russian government, who were, perhaps, more alive to the circumstances of the case than we were, had taken measures for cutting the submarine cables, and for equipping ships for that special purpose. It was said at the time, and on good authority, and was generally believed, that there was a carefully elaborated scheme for taking measures against our submarine cables in the eastern waters." It has also been pointed out to us by Percy A. Hurd, in the last issue of the Contemporary Review, referring to the cables which traverse the Mediterranean and Red Sea, "where we must expect them to be rendered useless whenever it suits any enemy to cut them."

"In case of an armed conflict between this country and England," said the Russian journal, Novoie Vremia, the other day, "our first task would be to block England's communication with India and Australia."

When we call to mind that the depth of the water between Land's End and the Wolf Rock is about 35 fathoms, and when we also observe that of the telegraph cables in the Java Sea and in the southwestern portion of the China Sea, on which our communication with the far East and Australia depends, there are some 3,500 miles lying in water less than 50 fathoms in depth (a great portion of it being in water of 20 or 30 fathoms), it is clear that the ease with which communication could be cut off is beyond dispute. In a report by the hydrographer on the proposed Pacific cable, we find that his general conclusion is in favor of triplicating, by means of sea cables, those portions of the existing route to Australia at present duplicated by foreign land lines. Doubtless, however, in view of the object lesson which we have referred to above, Admiral Wharton may see reason to modify his views regarding the value of the present routes to Australia and the far East.

BEER AND THE KIDNEYS.

DR. BOLLINGER, director of the Anatomico-Pathological Institution in Munich, asserts that it is very rare to find a normal heart and normal kidneys in an adult resident of that city. The reason for the kidney disease is the tax put upon these organs by the drinking of excessive amounts of beer, and the cardiac hypertrophy and degeneration are secondary lesions for the most part. Formerly, the population of the city was recruited by accessions from the country, but the abuse of beer has spread now to the rural communities, so that this source of healthy new blood is cut off.

A 6 inch Harveyized steel plate measuring 8 feet by 6 has stood a severe test in England. Five 100 pound Holtzer projectiles were fired at it from a distance of 30 feet with a velocity of 1,950 feet a second, and were shattered without perforating it, only slight surface cracks being found. The backing of the plate was merely bruised behind each impact.

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